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13. ABSTRACT (Maximum 200) The BRCA1 gene is responsible for an autosomal dominant syndrome of inherited susceptibility to breast and ovarian cancer. To date, over 100 disease-predisposing mutations have been identified in families. We are beginning to understand the influence of genetic factors on the incidence of breast cancer in largely Caucasian populations, very little is known about breast cancer risk attributable to inherited factors in African American and even less in Hispanic populations. We hypothesize that one major barrier to access to risk assessment in these populations is the lack of appropriate educational tools. In all populations, a major challenge of predictive testing will be patient education of scientific facts needed to make an informed decision. We propose the development of a bilingual (Spanish-English) reusable, fifth-grade level, self-paced instrument for use in genetics education prior to discussions of informed consent or risk assessment. The book will be organized around 10 concepts of increasing complexity from genes to risks and benefits of genetic testing. An 11-question evaluation instrument of this educational intervention has been developed and tested for reliability. Collaborations with two institutions will allow access to non-English-speaking Hispanic families.				
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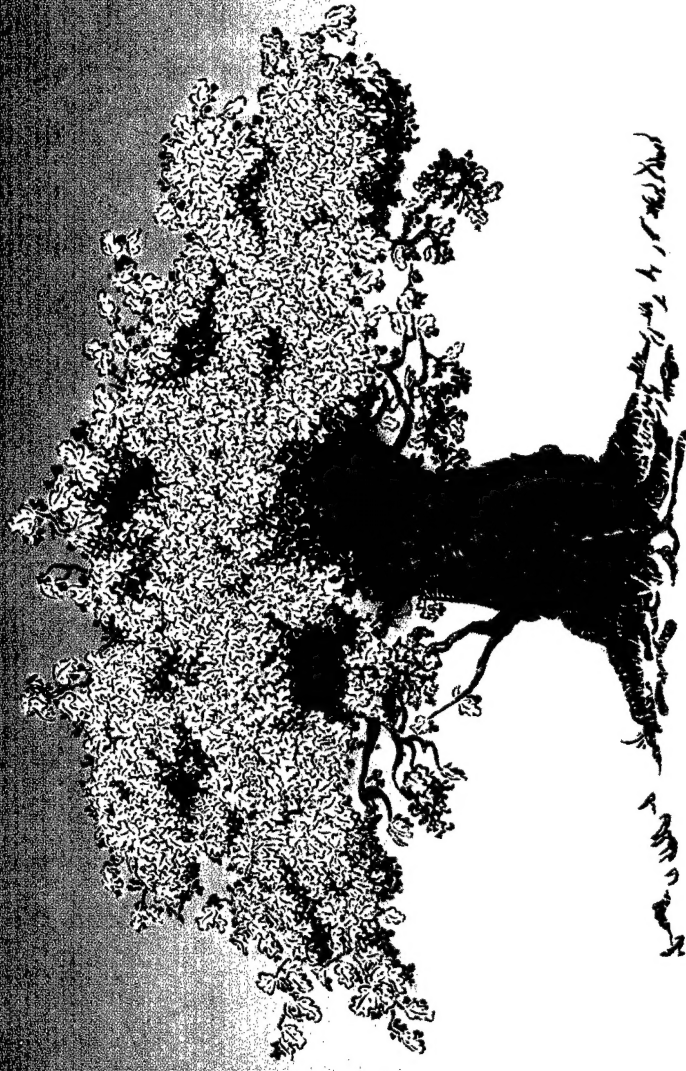
UNDERSTANDING

CANCER & GENETICS



A COUNSELING HANDBOOK

UNDERSTANDING CANCER & GENETICS



A COUNSELING HANDBOOK

Written and Produced by:

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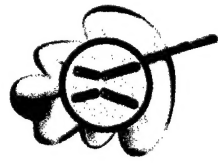
of the University of Michigan Comprehensive Cancer Center

With financial support from the United States Army, the National Institutes of Health,
and the Susan G. Komen Breast Cancer Foundation

This handbook and the accompanying CD-ROM are designed to help you understand how breast cancer develops and how it can be inherited in families.

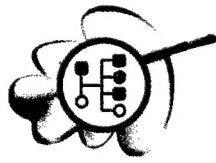
Learning about cancer and genetics is like climbing a tree. You must first learn the basics before you can move on to other information. In this book, we will start at the trunk with Basic Genetics and Cancer and Genetics. Then, we'll branch out to the other topics: Genes Associated with Breast Cancer, Genetic Testing, and Managing Your Cancer Risk.

Let's begin the climb...



BASIC GENETICS

Learn what genes are and how they are inherited.



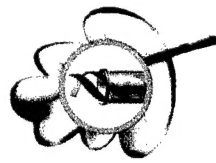
CANCER AND GENETICS

Learn how changes in hereditary materials cause cancer to grow.



GENES ASSOCIATED WITH BREAST CANCER

Learn about two genes that raise the risk for breast cancer in some families.



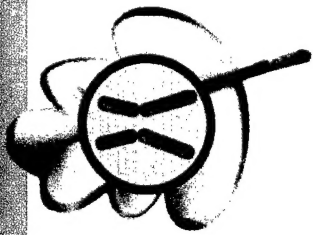
GENETIC TESTING

Learn about genetic testing and its limitations, benefits, and risks.



MANAGING YOUR CANCER RISK

Learn about things you can do to lower your risk of cancer.



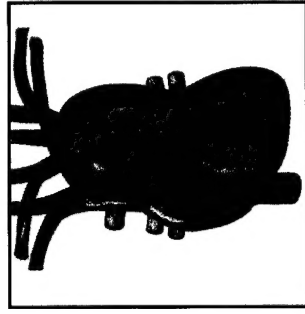
Basic Genetics

In this section, we will learn some basic concepts of genetics:

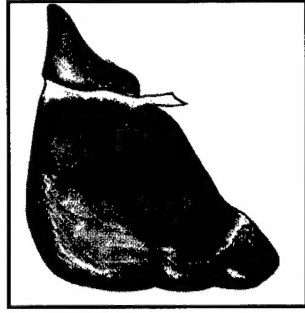
- cell
- nucleus
- chromosomes
- genes
- DNA
- mutations

These concepts will help you later when you learn about how cancer runs in families and how it grows in the body.

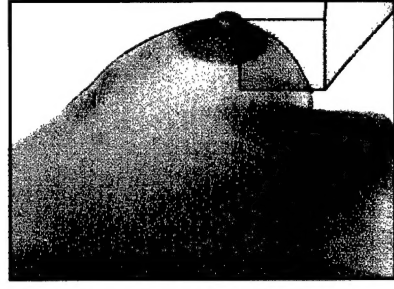
The Cell



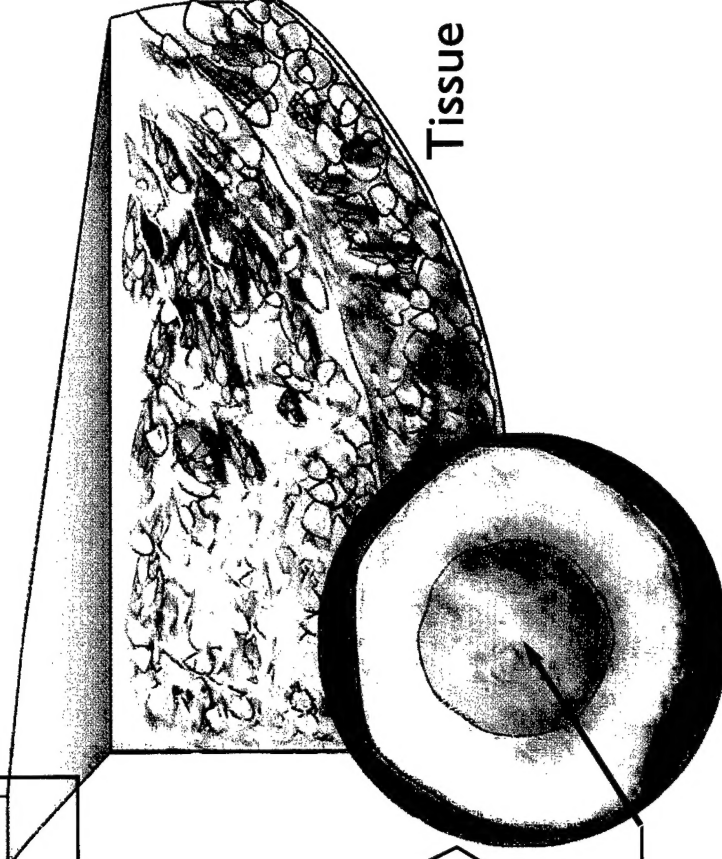
Heart



Liver



Breast



Cell

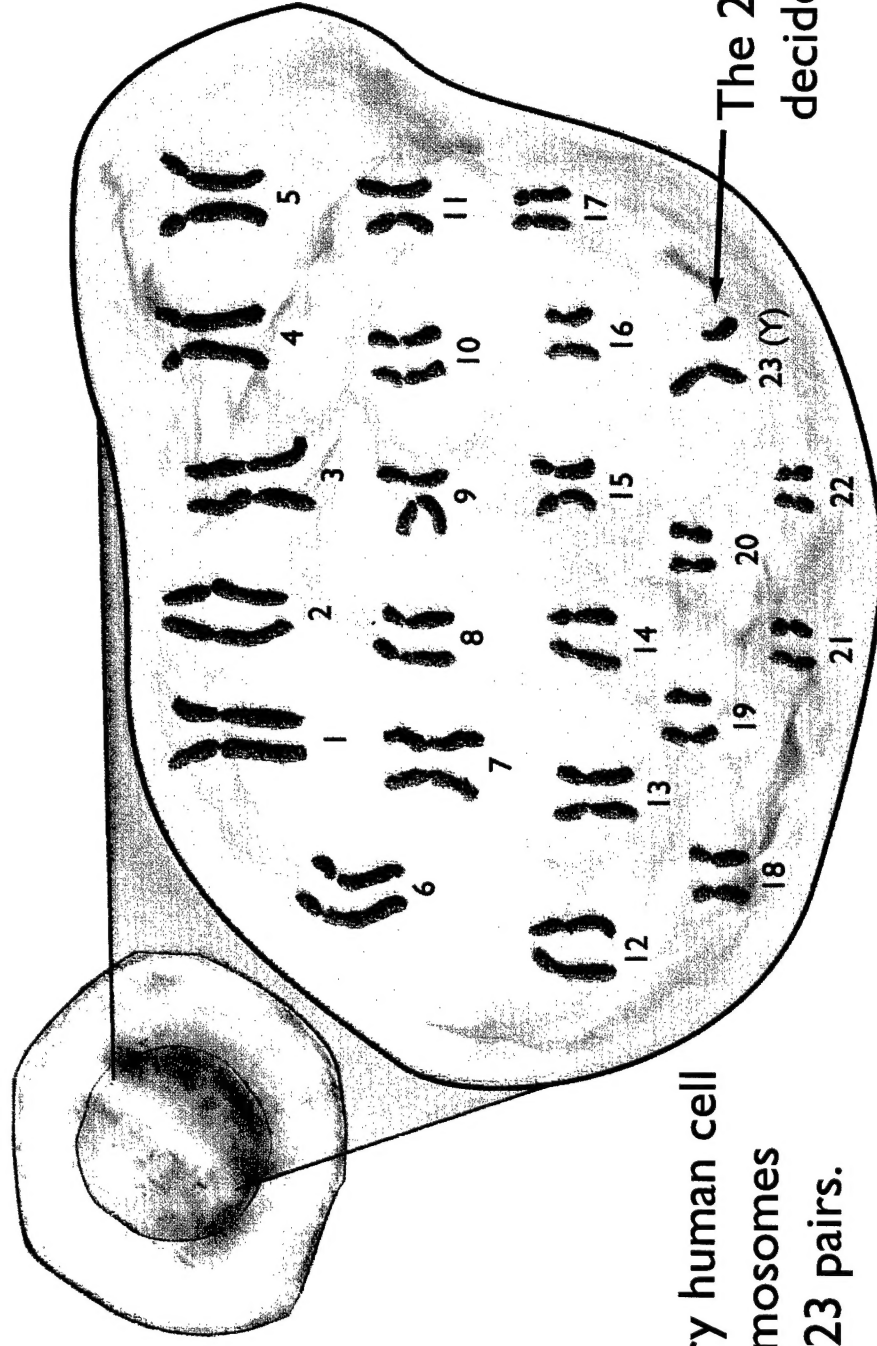
All of the body tissues, including organs such as the heart, liver, and breast, are composed of **cells**.

Nucleus

The **nucleus** is the control center of the cell.
Hereditary materials are found in the nucleus.
Hereditary means passed on in families.

Chromosomes

The **chromosomes** contain the hereditary material. They are found in nearly all cells.



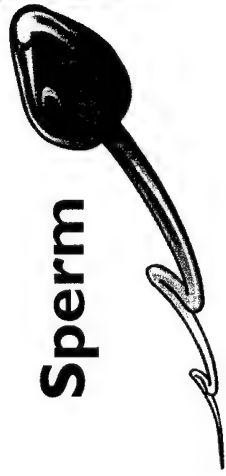
Almost every human cell has 46 chromosomes arranged in 23 pairs.

The 23rd pair decides sex.

Each pair has one chromosome from the mother (red) and one chromosome from the father (blue).

Chromosomes and Reproduction

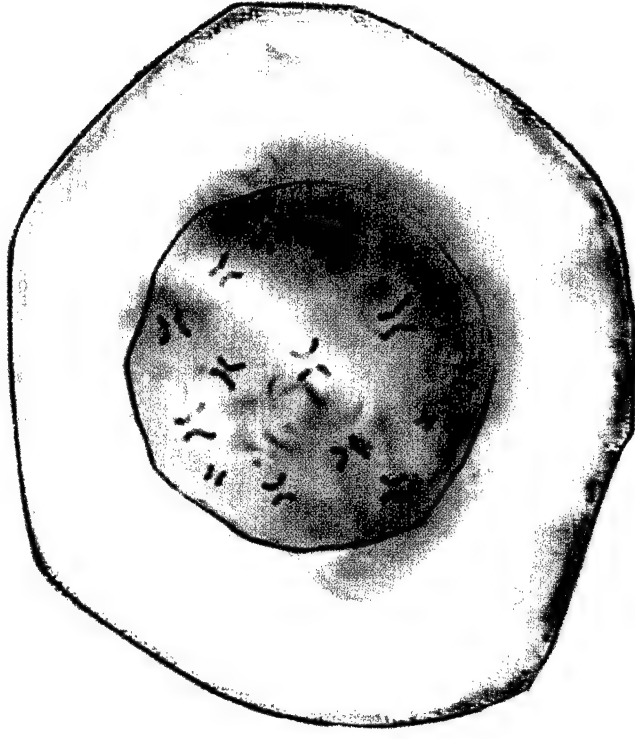
The first human cell is formed when the egg and sperm come together.



Sperm



Egg



New Cell

The mother's egg carries 23 chromosomes and the father's sperm carries 23 chromosomes. The result is a new cell with 46 chromosomes (23 pairs).

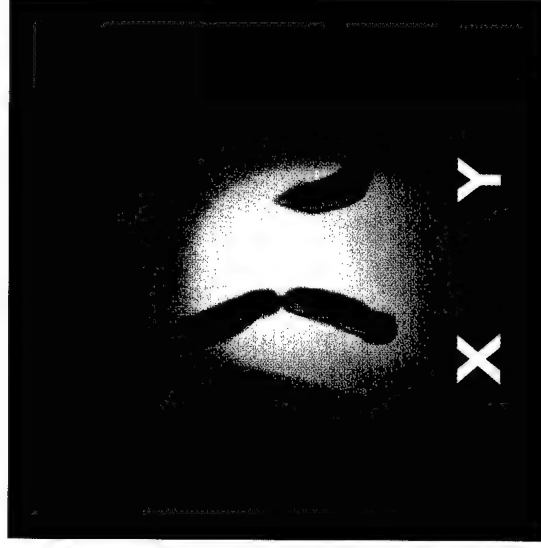
This cell divides many times to form a baby.

How Sex is Decided

The 23rd pair of chromosomes decides the baby's sex.

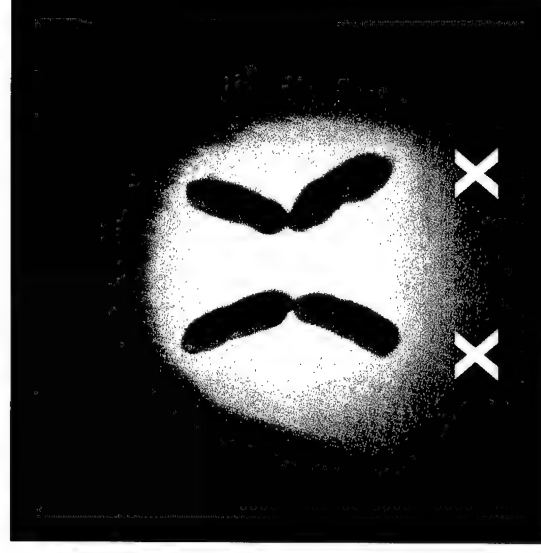
The mother's egg gives an X chromosome.

The father's sperm can give an X or Y chromosome.



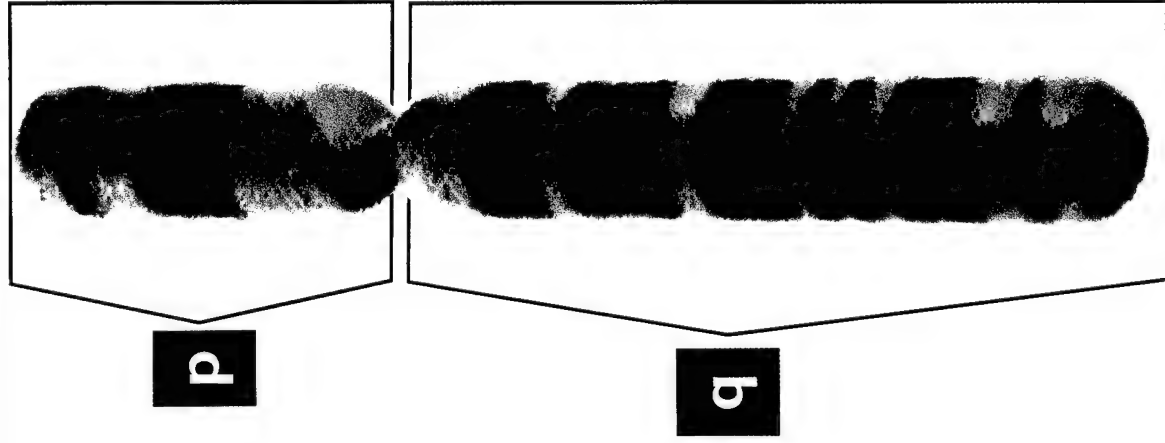
Male Chromosomes:

Males have an X and Y chromosome in the 23rd pair.



Female Chromosomes:

Females have two X chromosomes in the 23rd pair.



This is what a chromosome looks like up close.

Remember, a chromosome holds your hereditary material.

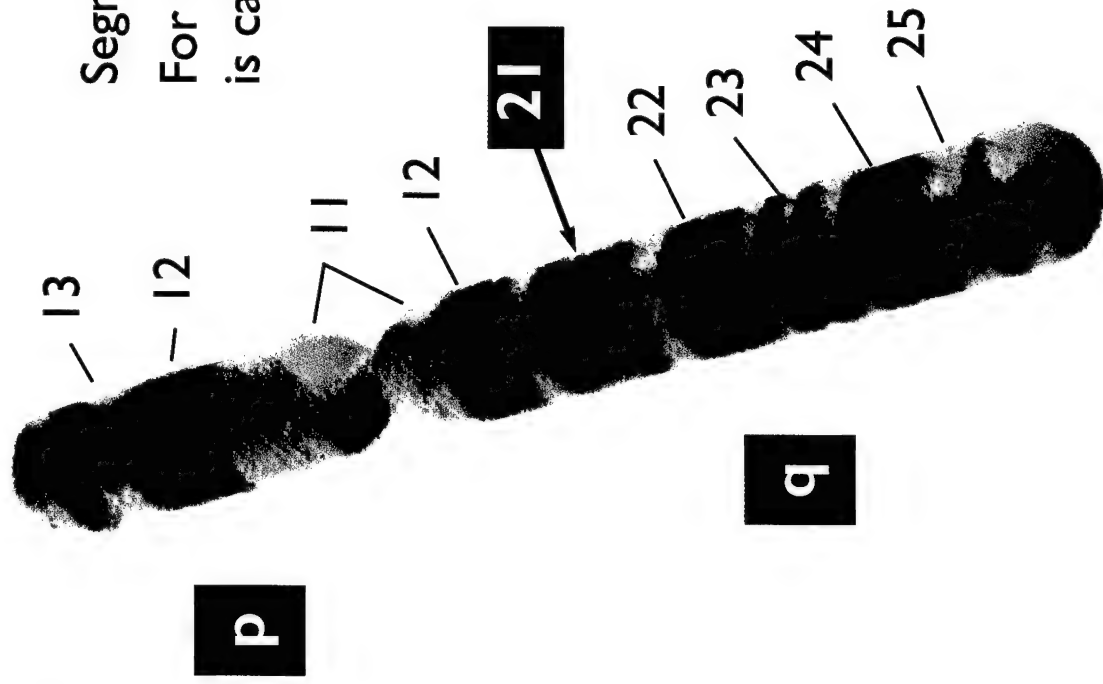
It has two portions called **arms**. The two arms are separated by a pinched-in area.

The short arm is called “p.”

The long arm is called “q.”

The bands correspond to different areas, or **segments**, of the chromosome.

Chromosome 17

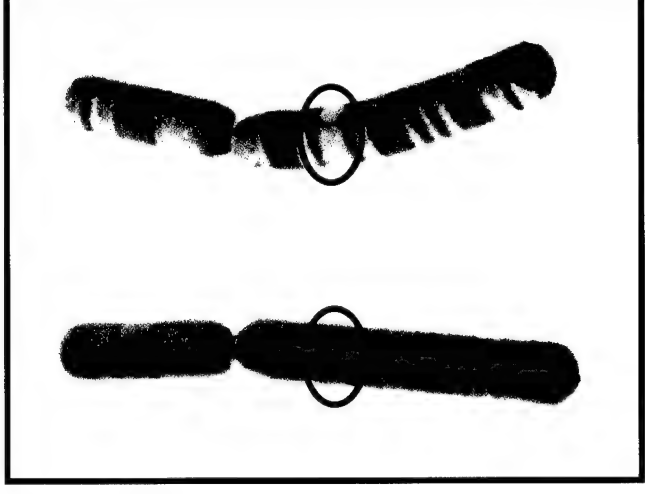


Segments of the chromosome are labeled with numbers.

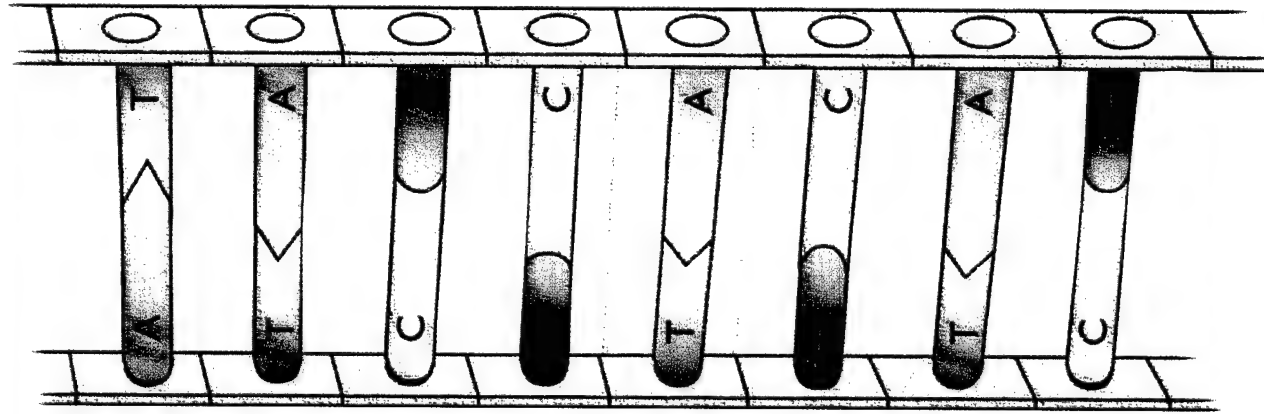
For example, one specific location on the chromosome 17 is called "17q21".

This is just like an address. It means you are looking at the long arm (q) of chromosome 17 at segment 21.

- Each chromosome contains smaller units known as **genes**.
- There are about 100,000 different genes in a human.
- Each gene has a specific job to do in the body.

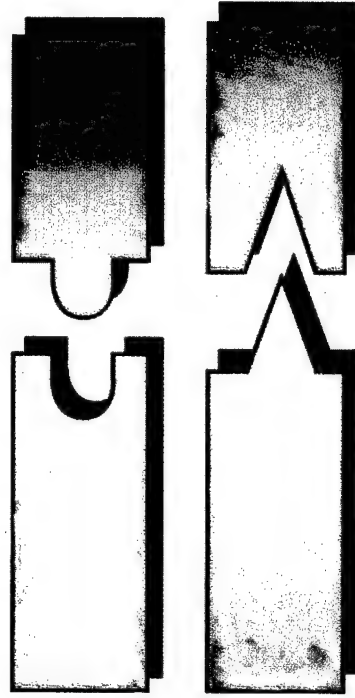


- Like chromosomes, genes occur in pairs.
One is found on the chromosome from the mother and the other is on the chromosome from the father.



DNA is the chemical that makes up your genes.

Each gene is made of a special piece of DNA that tells it what to do.



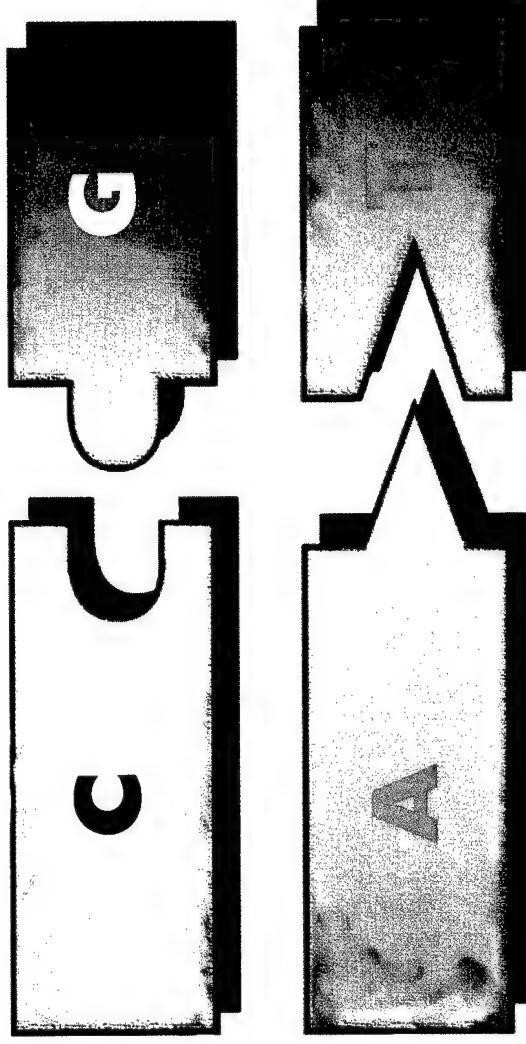
The DNA has two strands linked by chemical bonds, much like rungs on a ladder.

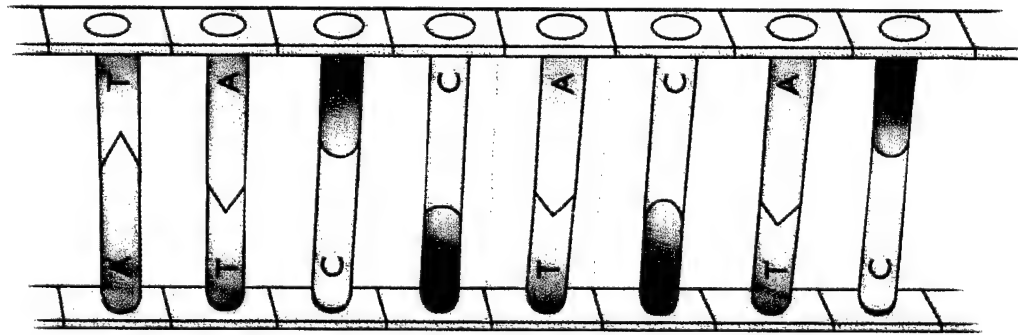
The chemical bonds fit together in a specific pattern, like pieces of a puzzle.

The puzzle pieces are called **nucleotides** (new-klee-o-tides).
There are four different kinds of nucleotides: A, C, T, and G.

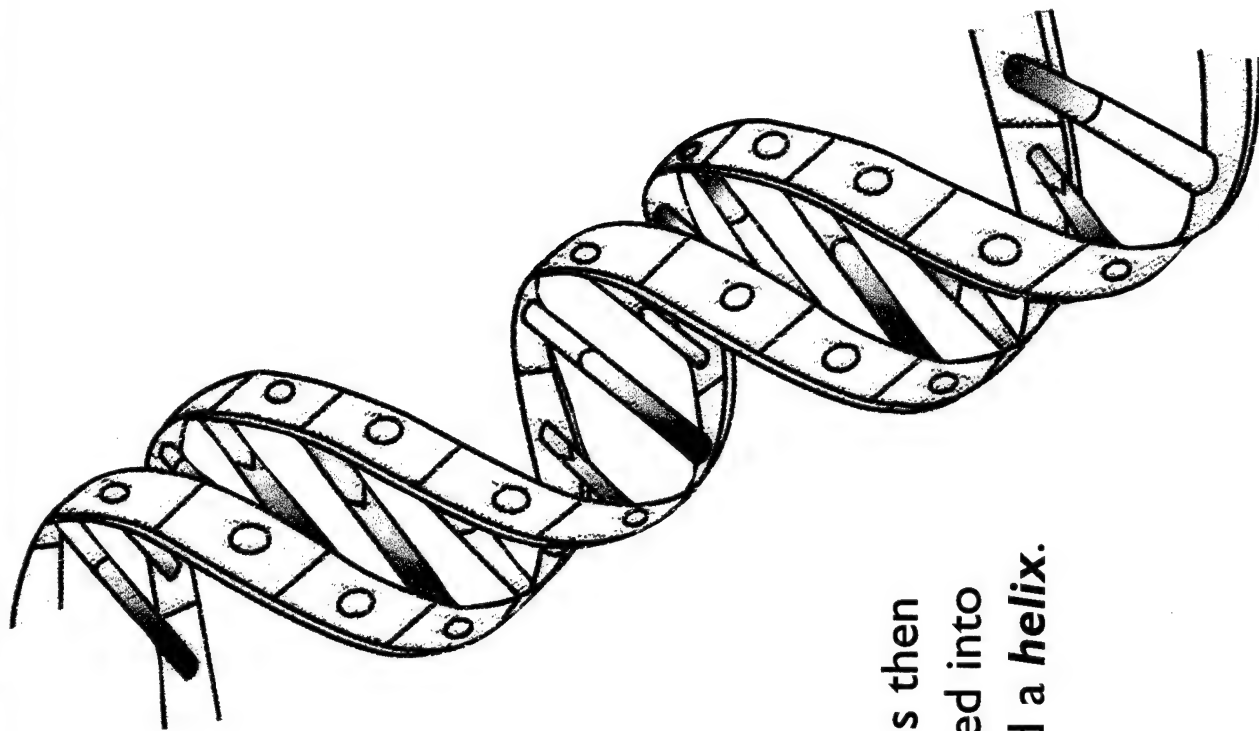
A and T always fit together.

C and G always fit together.

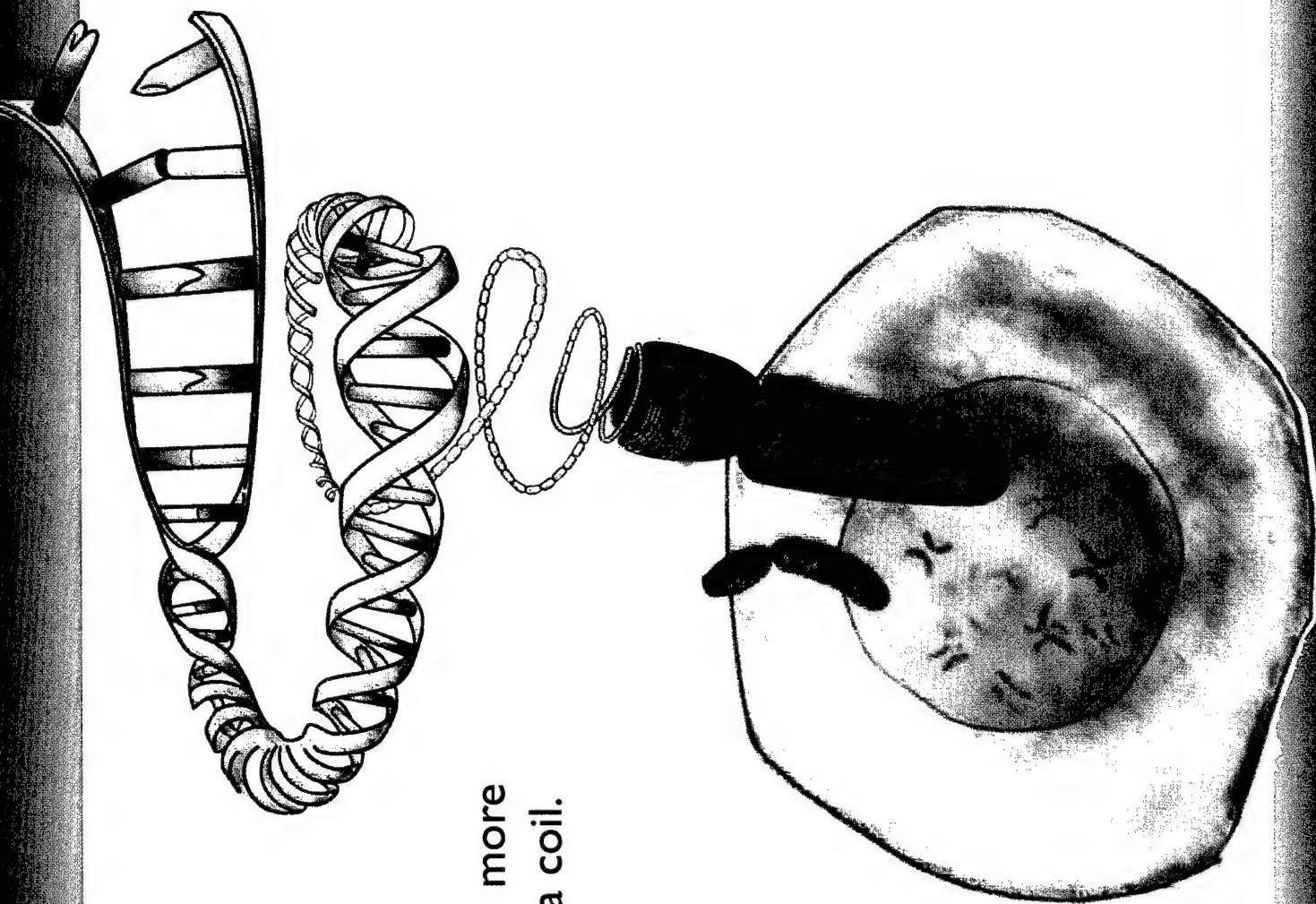




Pairs of puzzle pieces line up to form a ladder.



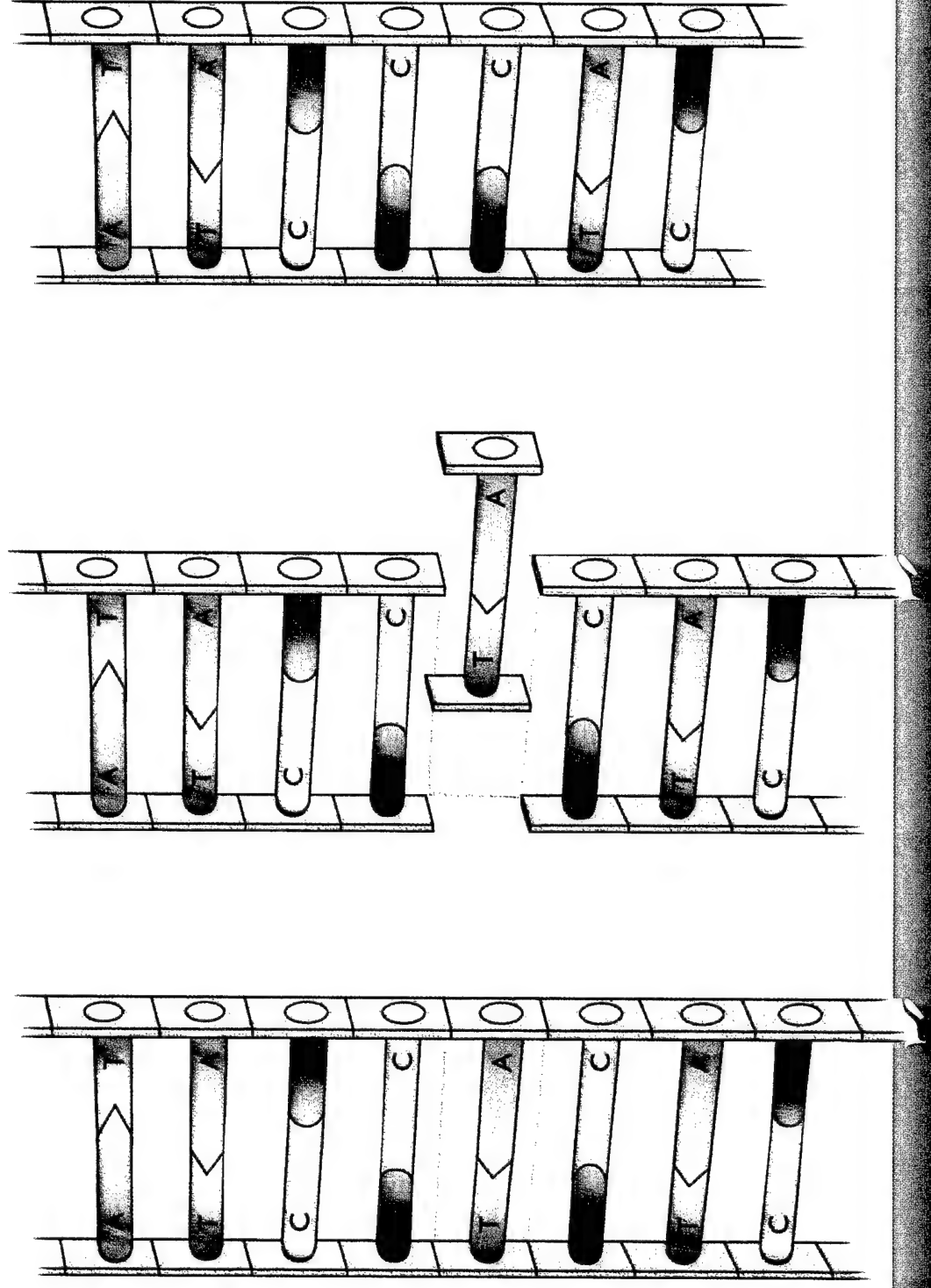
The ladder is then tightly twisted into what's called a **helix**.



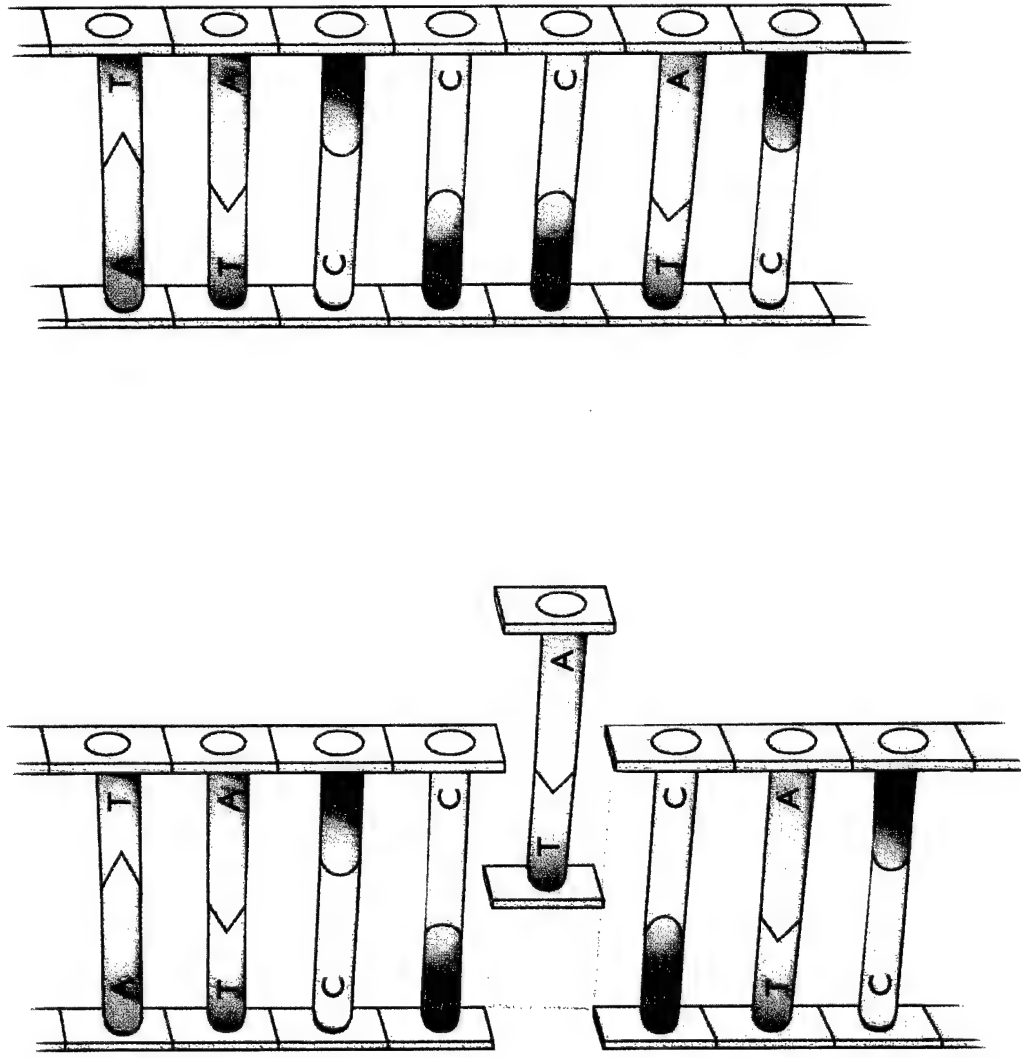
The helix is twisted even more into a chromosome like a coil.

Remember how DNA is like a ladder? And how the nucleotides fit together like puzzle pieces?

When a pair of puzzle pieces is missing or added, the ladder changes. This is called a **mutation**.

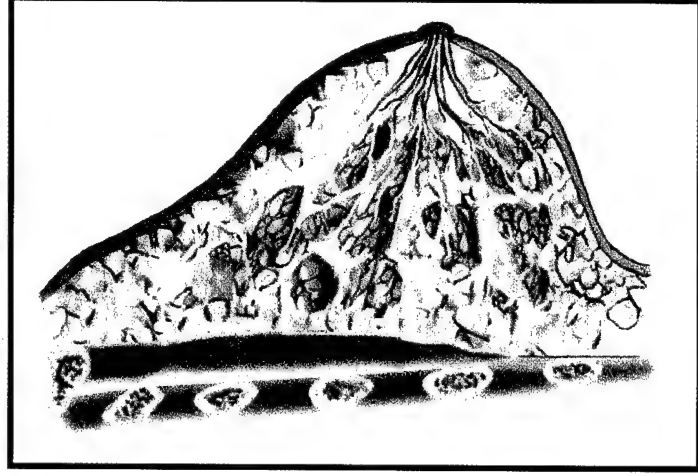


When the ladder changes, your genes do not do the right job in your body.

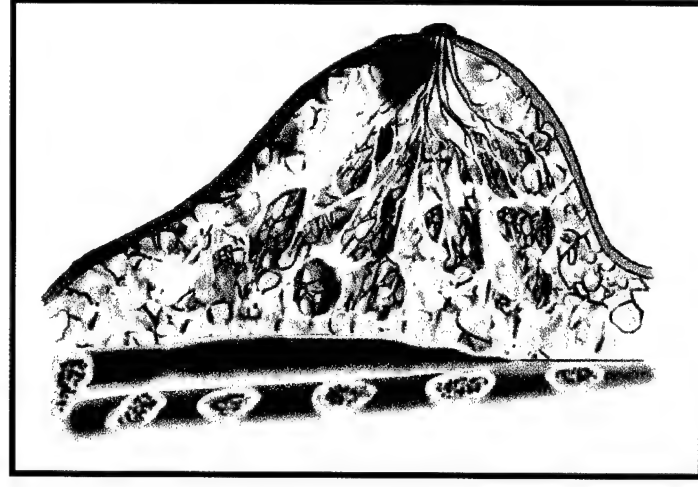


Mutations

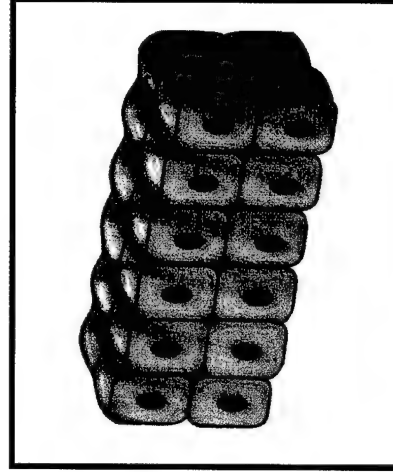
Most mutations occur as your body cells divide. These are usually not harmful to you. Some mutations are harmful and can cause disease in cells.



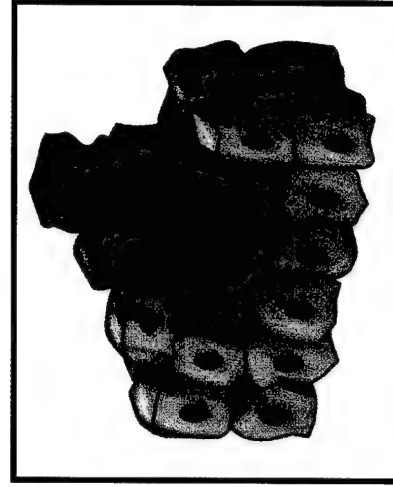
Breast without tumor



Breast with tumor

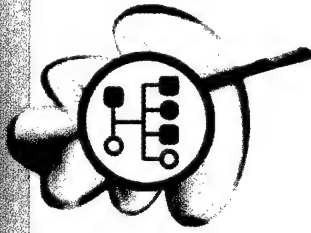


Normal cells



Tumor develops

We have come to the end of this section. Now that you have more knowledge about basic genetics, you can go on to the next section, “Cancer and Genetics.”

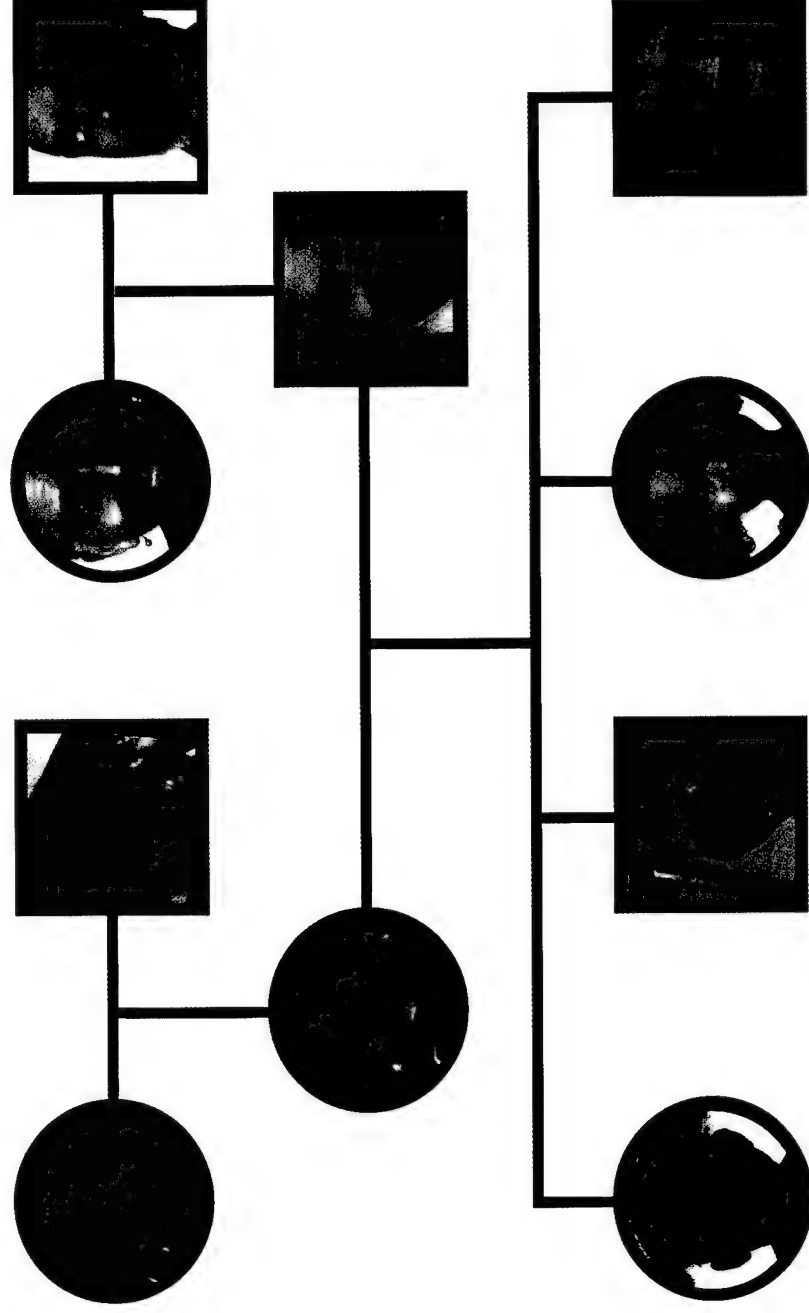


Cancer & Genetics

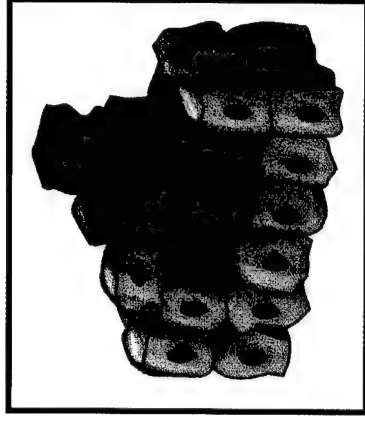
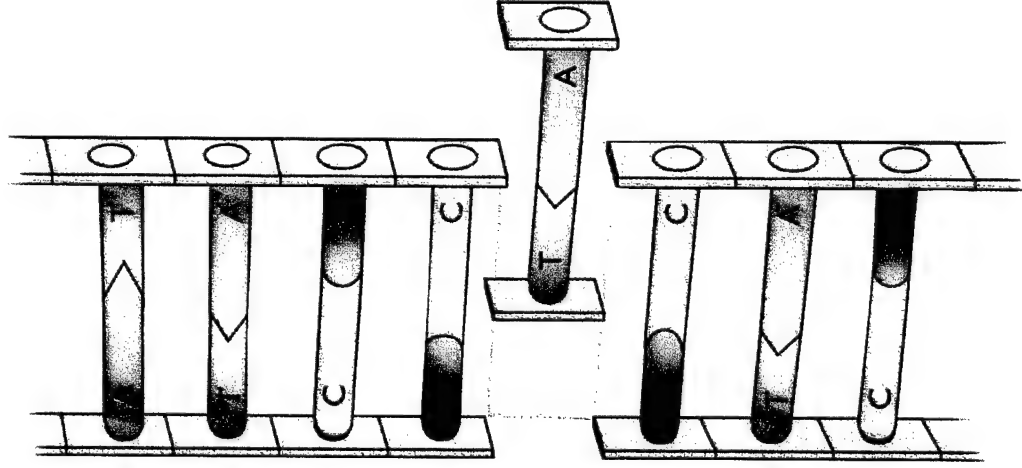
Some mutations may run in a family.
In this section, we will look at how
cancer grows and how the risk for
cancer can be passed on in a family.

You will learn about:

- sporadic cancer
- inherited cancer
- pedigrees

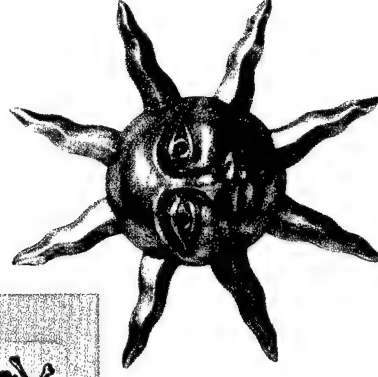


All cancers result from changes in the DNA of cells (mutation).
Some mutations associated with cancer run in families.



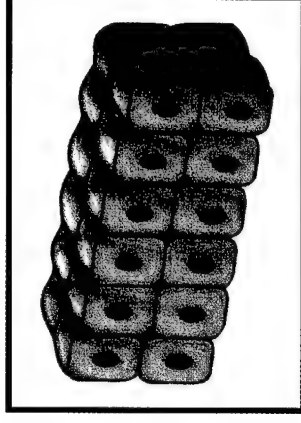
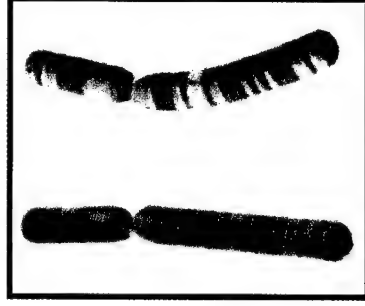
Cancers that do not run in families are called **sporadic** cancers. Sporadic cancers happen by chance or by causes that do not run in families.

- harmful chemicals,
- radiation (for example, from the sun),
- and aging.

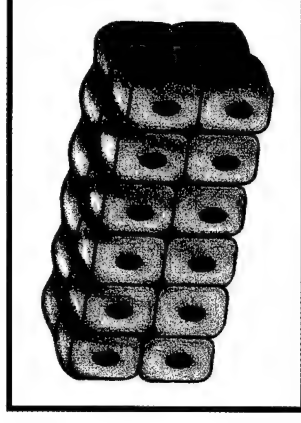
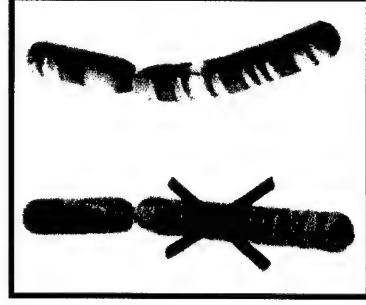


How Sporadic Cancer Develops

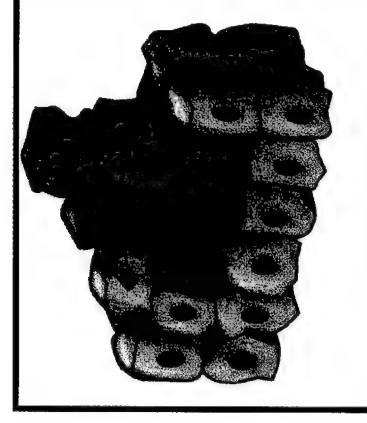
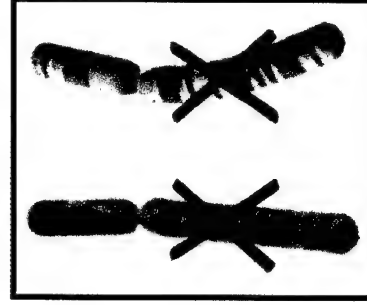
**Chromosomes
normal at birth**



**First mutation
occurs in the gene
of a cell during a
person's lifetime**



**Second mutation
occurs in the gene's
other copy in the
same cell and
tumor develops**

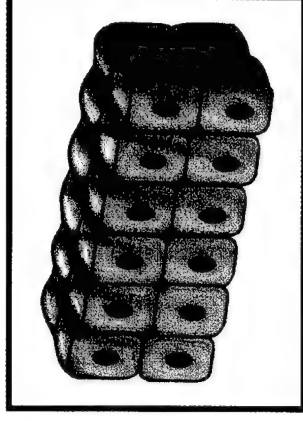
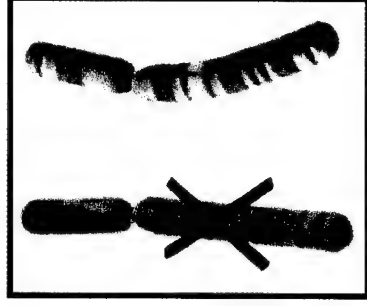


Other types of cancer are *inherited* or passed on in families.

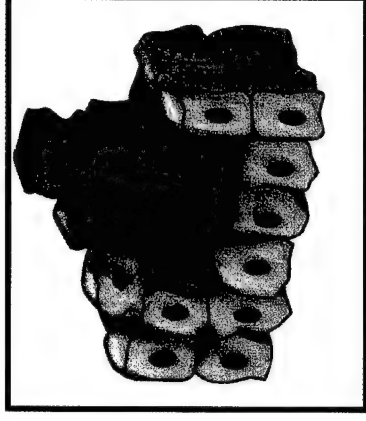
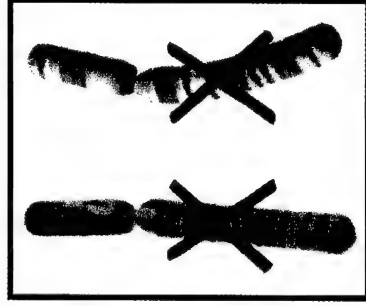
A person can inherit a mutation that raises his/her risk for cancer.

How Inherited Cancer Develops

First mutation is inherited and is found in all body cells



Second mutation occurs during a person's lifetime and tumor develops



Three Main Differences

There are three main differences between sporadic and inherited cancers.

Sporadic cancer is associated with:

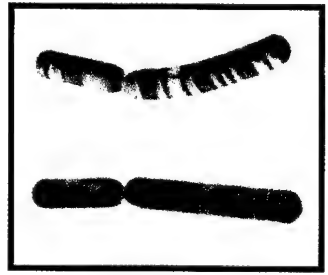
- Single Tumors
- One affected breast (if breast cancer)
- Later onset in life

Inherited cancer is associated with:

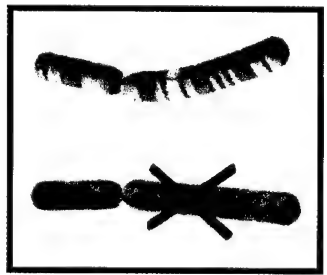
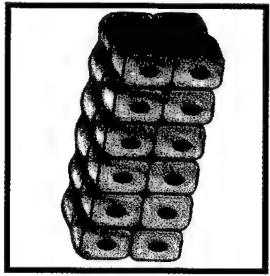
- More than one tumor
- Two affected breasts (if breast cancer)
- Earlier onset in life



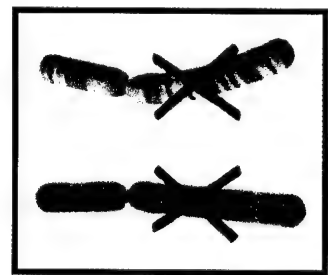
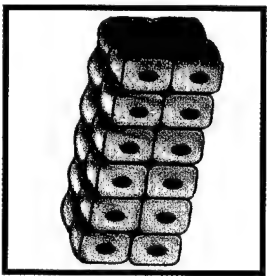
Sporadic



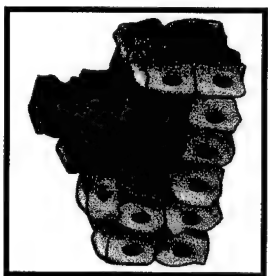
Normal at birth



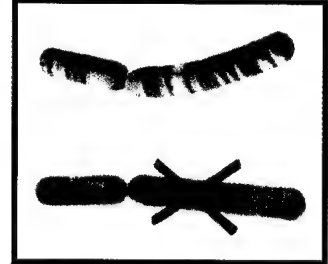
Mutation



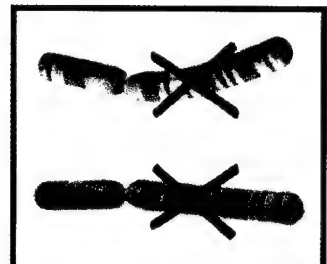
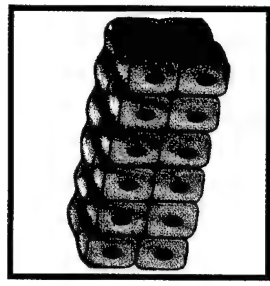
Tumor develops



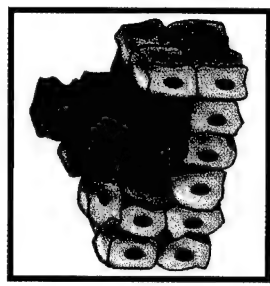
Inherited



Mutation at Birth



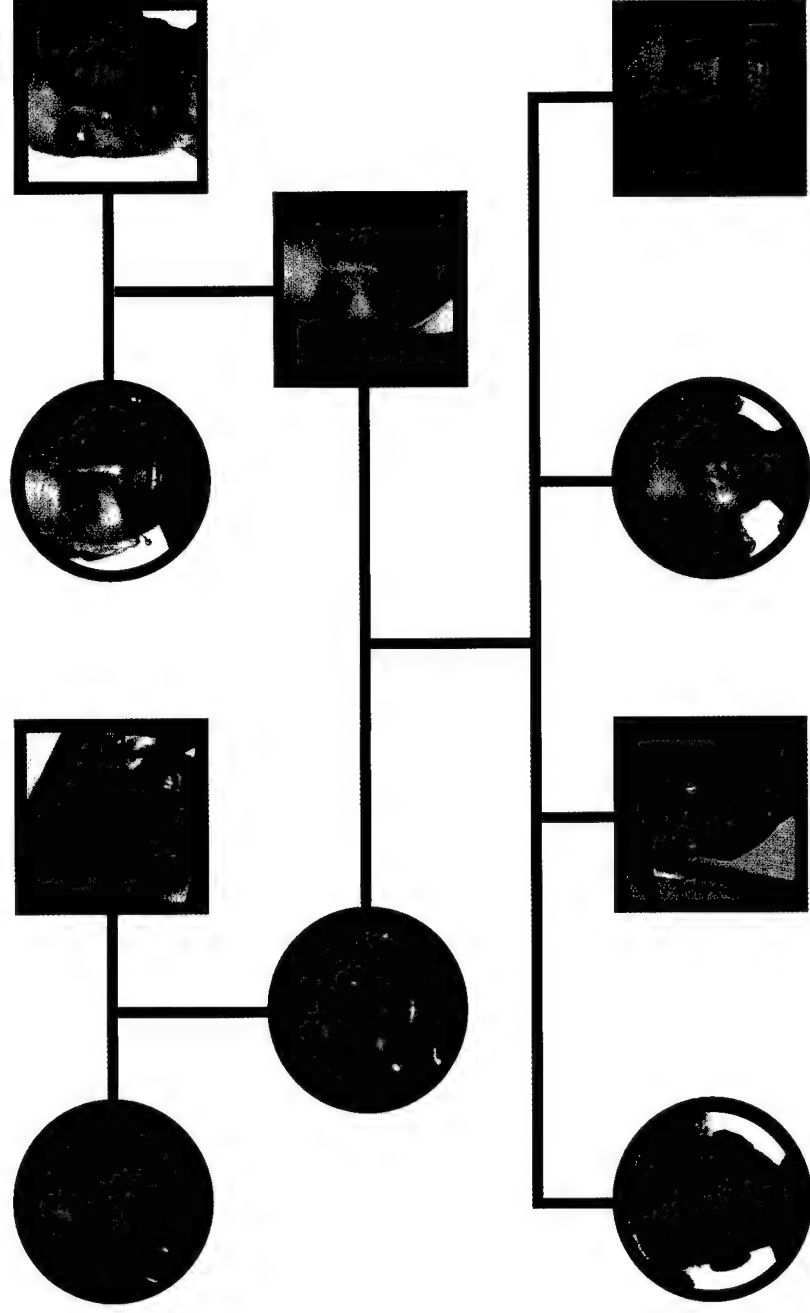
Tumor develops



Pedigrees

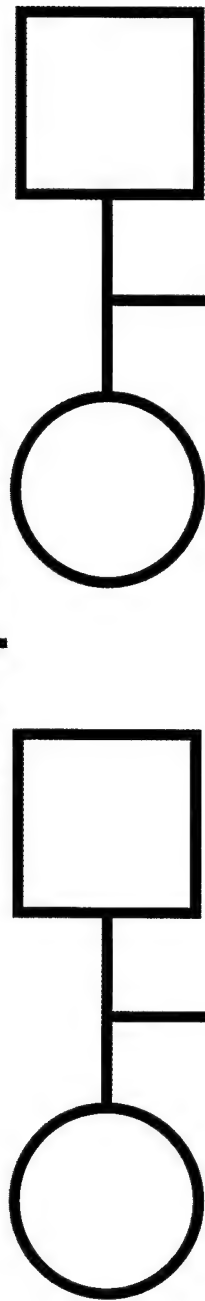
To find out if cancer runs in your family, doctors and genetic counselors look at your family's history of cancer.

A picture of your family's history is called a **pedigree**.



Here is a pedigree.

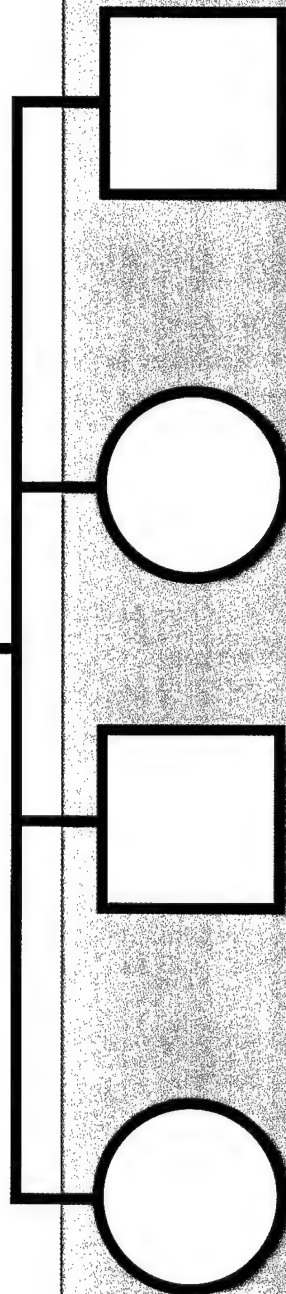
Grandparents



Parents



Children

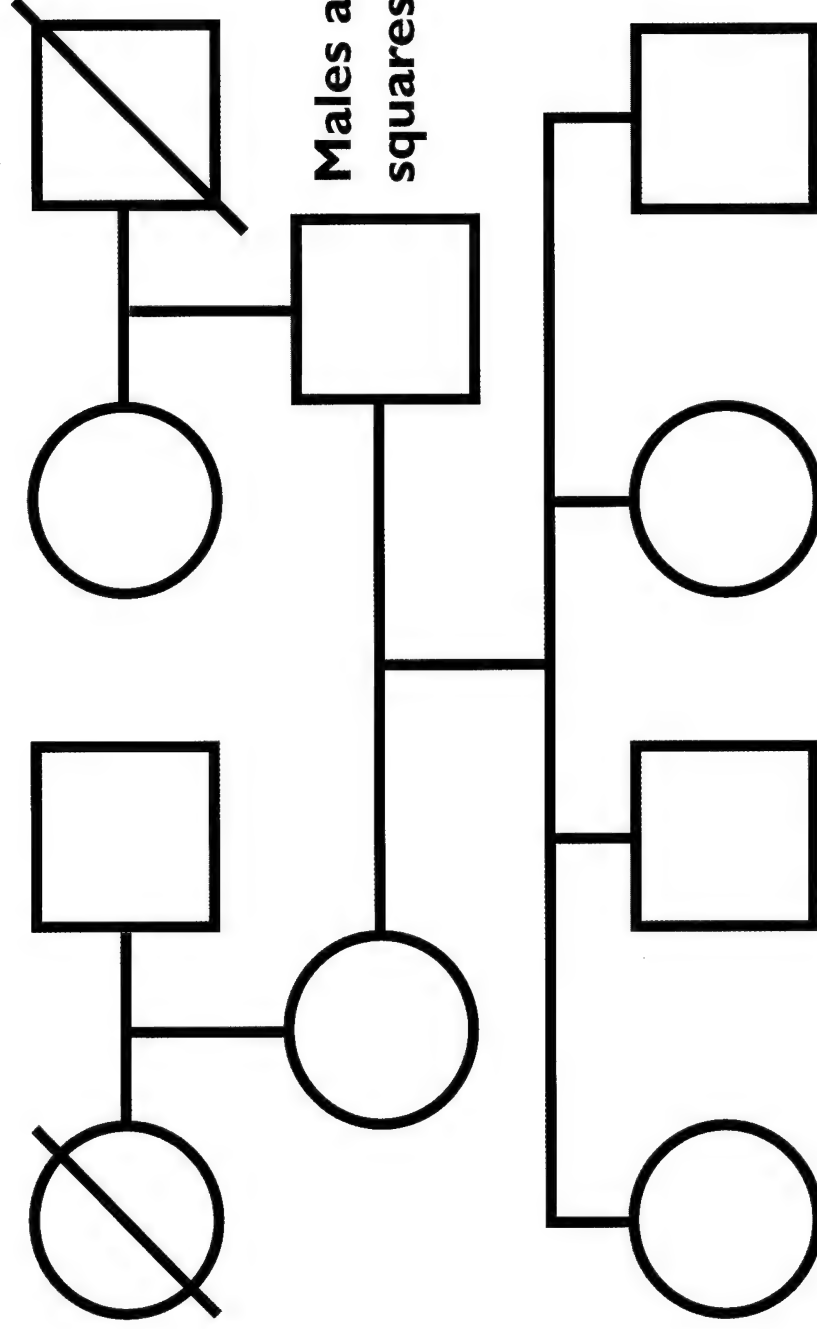


Pedigrees

A diagonal line through a circle or square means the person has died.

Females are circles.

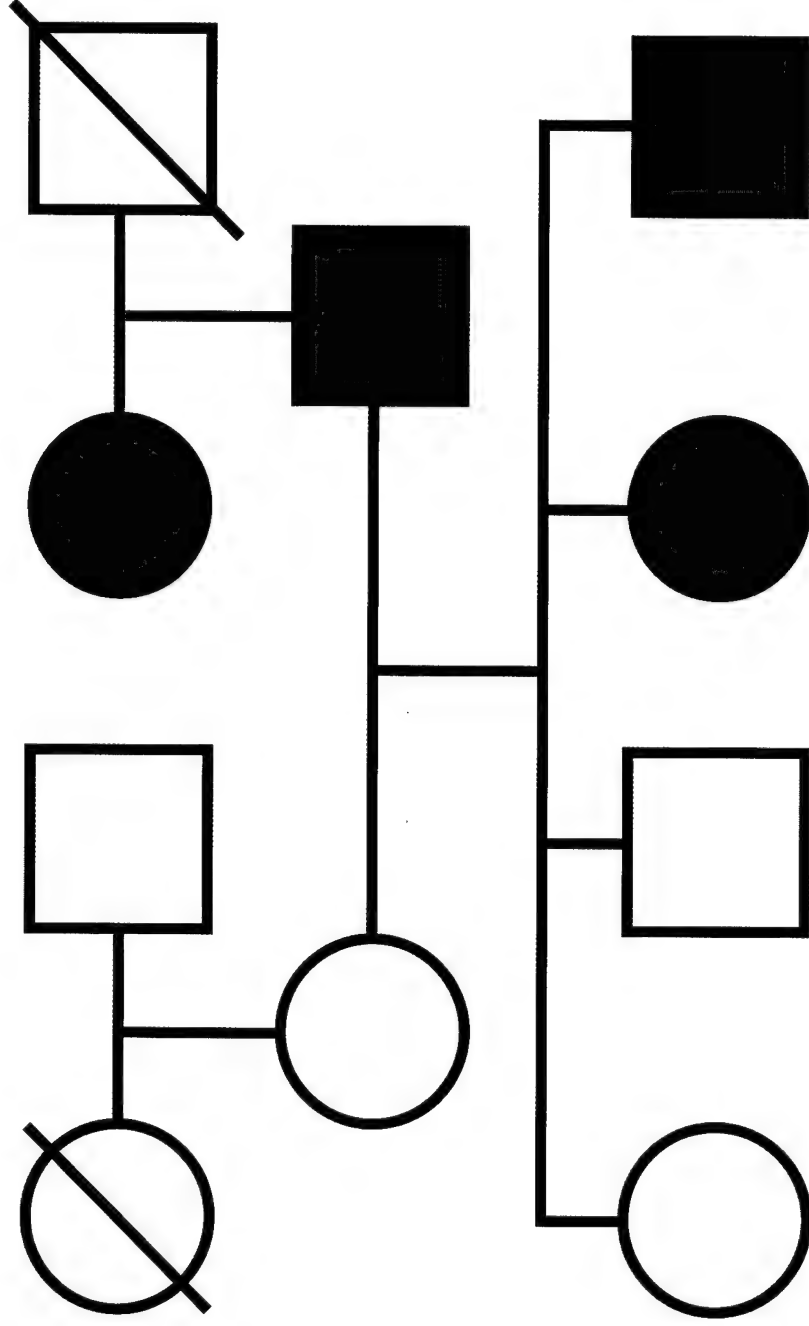
Males are squares.



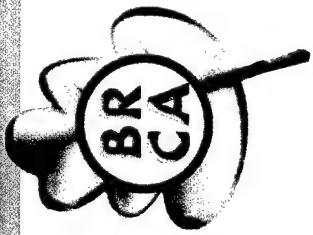
Pedigrees

If a circle or square is solid, it means that the person:

1. has a disease, or
2. is a carrier. This means the person has a mutation but may or may not have the disease.



Now that you have a better understanding of cancer and genetics, you may branch out to other topics. You can repeat the first two chapters if you want to review what you have learned.



Genes Associated with Breast Cancer

Breast cancer may run in families.

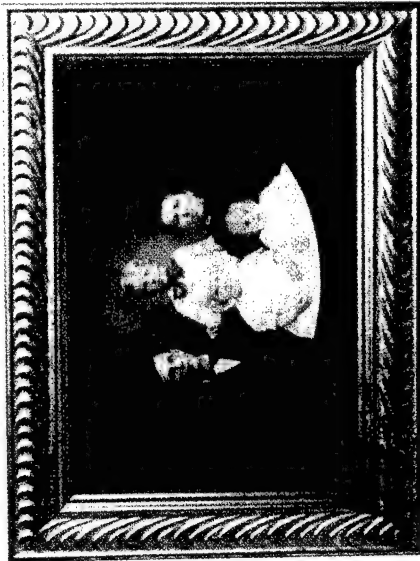
In this section, you will learn about:

- ▣ inherited breast cancer
- ▣ tumor suppressor genes
 - ▣ *BRCA1*
 - ▣ *BRCA2*
- ▣ risks for breast cancer
- ▣ screening for breast cancer

Breast cancer is a common disease in the United States.

The American Cancer Society says there will be over 180,000 new cases of breast cancer in the United States this year.

It will account for more than 46,000 deaths during the year.



Breast Cancer

The risk of getting breast cancer is higher among women whose close relatives, such as a mother or sister, have the condition.

For this reason, many people with a family history of breast cancer are very concerned about their risk for this disease.



Inherited Breast Cancer

There are specific genes which may be linked to breast and ovarian cancer. These are called *tumor suppressor genes*.

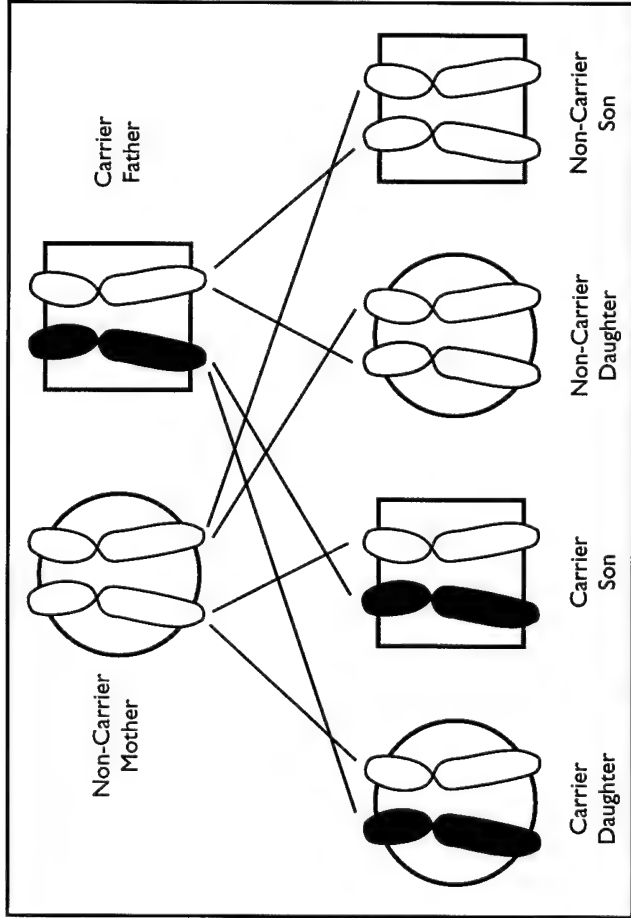
A small number of breast cancer cases (5–10%) are caused by an inherited mutation in a tumor suppressor gene.

Even if more than one relative has breast cancer, it does not mean it is due to an inherited mutation.

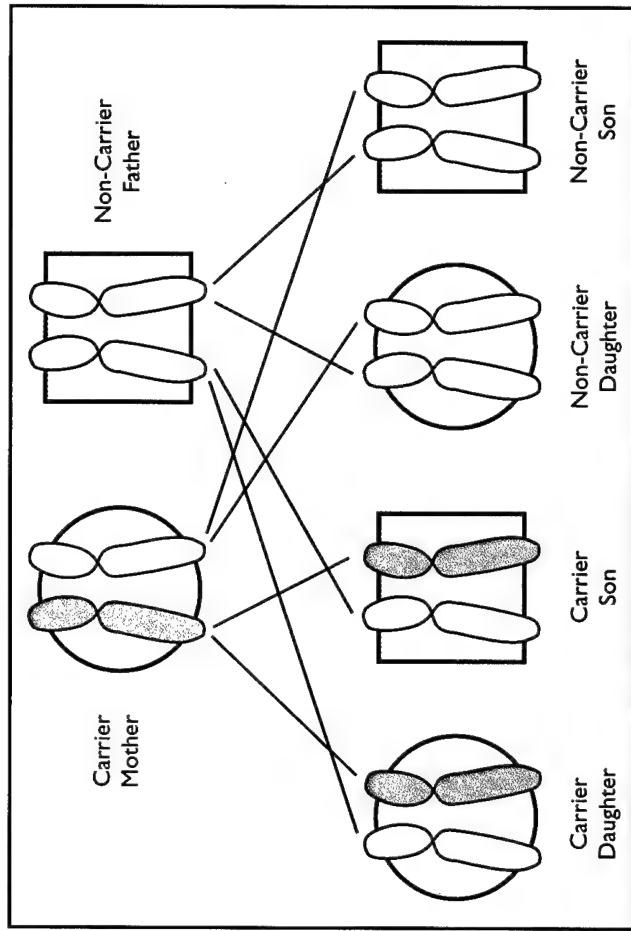
Women who do not have a mutation will have an approximately 11% (1 in 9) chance of getting breast cancer in their lifetime.

Inherited Breast Cancer

Each parent with a cancer-causing mutation has a 50% (1 in 2) chance of passing the mutation on to each child. This is because only one of each parent's chromosomes is passed on to the child during reproduction.



Carrier father



Carrier mother

BRCA1 means Breast Cancer Gene 1.

In 1994, **BRCA1** was found on chromosome 17q21. —————→

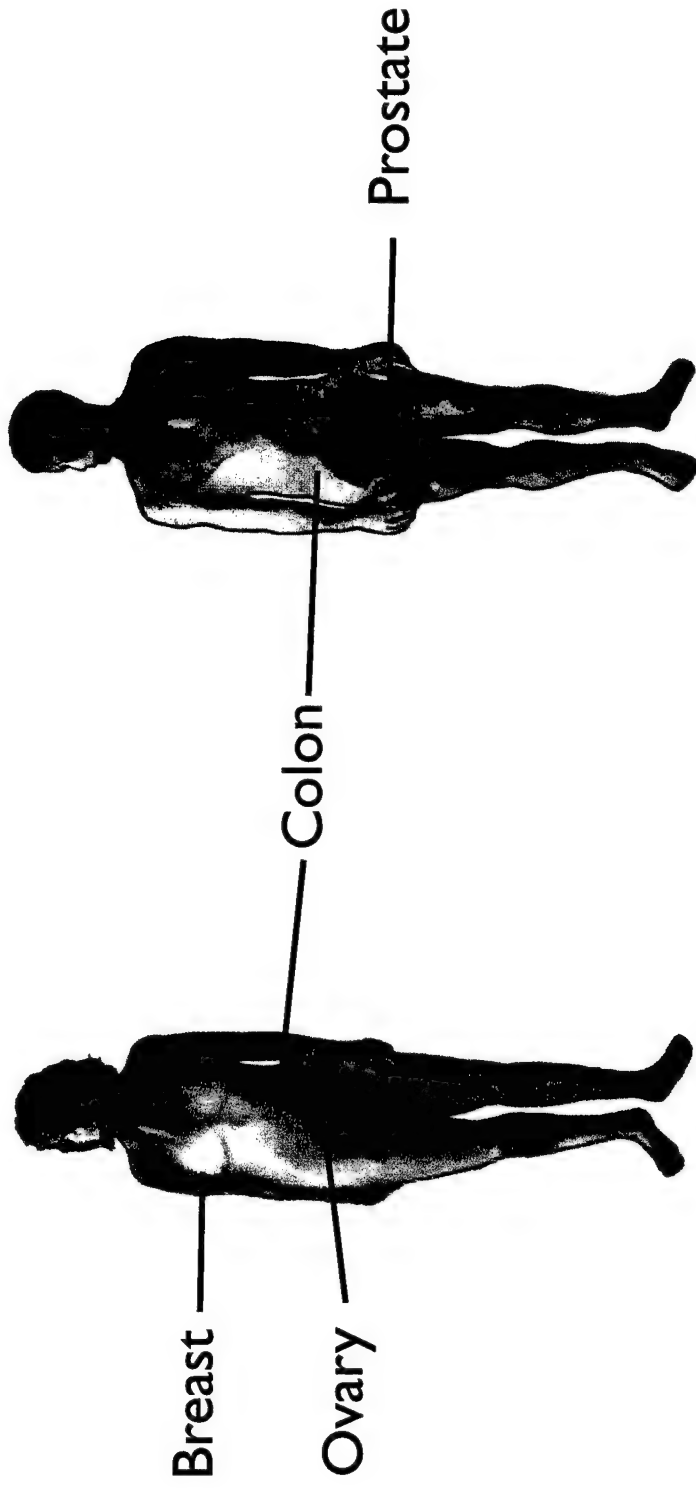


The gene has over 100 different mutations.

Women who carry a mutation of this gene have a higher risk of breast cancer. Breast cancer due to an inherited mutation more often occurs before menopause and affects both breasts (bilateral).

Mutations in **BRCA1** are also linked to a higher risk of ovarian cancer.

- Breast cancer caused by *BRCA1* only affects women. But men can carry a mutation and pass it on to their children.
Men who have a mutation may have a higher risk of prostate cancer than men who do not.
Both men and women with a mutation may have a higher risk of colon cancer than those who do not.



BRCA2 means Breast Cancer Gene 2.

This gene was found in 1995 on chromosome 13q12-13.

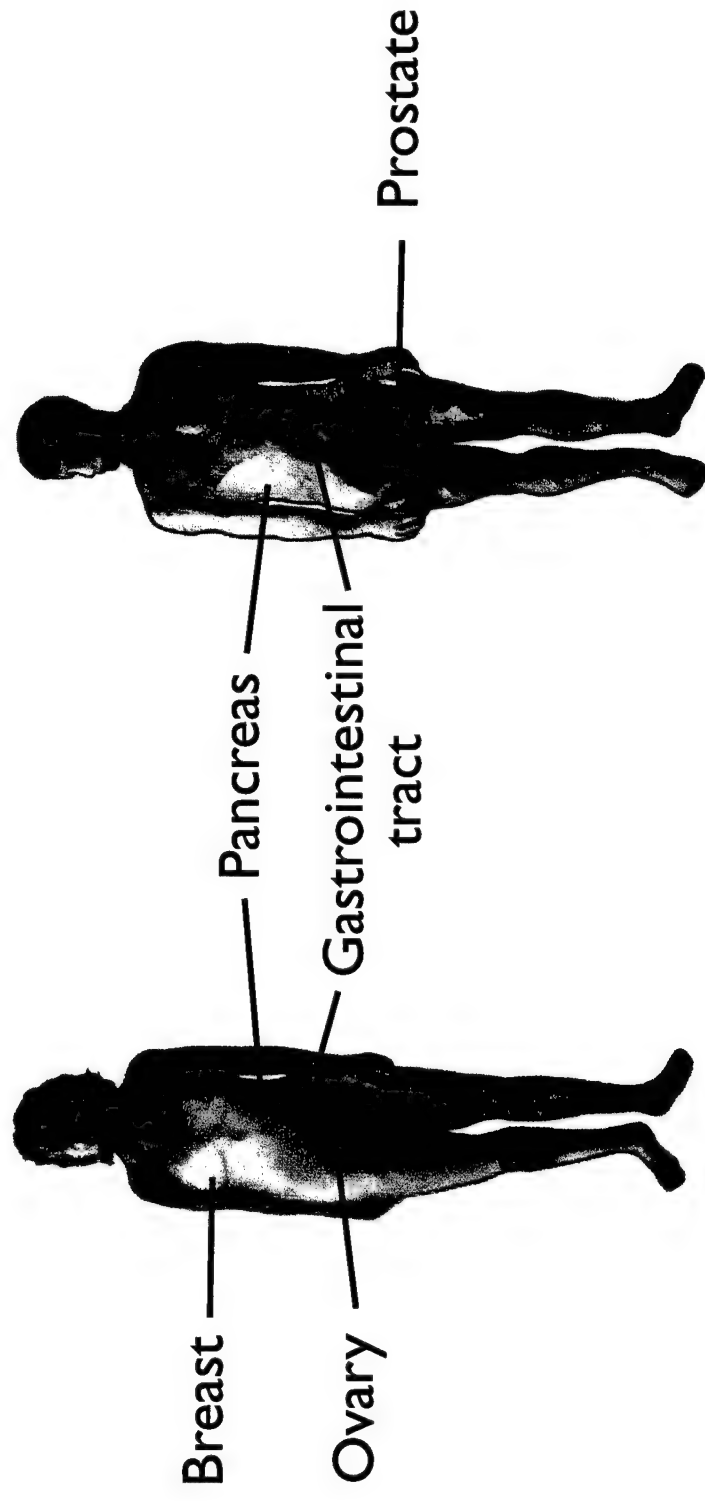
Mutations in this gene are linked to breast cancer in men and women.

In women, breast cancer linked to *BRCA2* often occurs before menopause and can affect both breasts.

Ovarian cancer is also linked to *BRCA2*.

Research is underway to find out if this gene is linked to other cancers, such as cancers of the prostate, pancreas, and gastrointestinal tract.

Research is also going on to find out how many mutations of this gene there are and which ones may cause breast cancer.



Genes Associated with Breast Cancer

It is important to remember that not all women who have a mutated gene will get breast cancer.

The reasons for this are not clear and are being studied. Because of the high rate of breast cancer in this country, those who do not have a mutation still have a risk for this disease.

All women should know about risk factors for breast cancer, such as:

- Family history of breast cancer
- First pregnancy over 30 years of age
- Early onset of menstruation (periods)
- Aging
- Pre-cancerous changes in the breast

Genes Associated with Breast Cancer

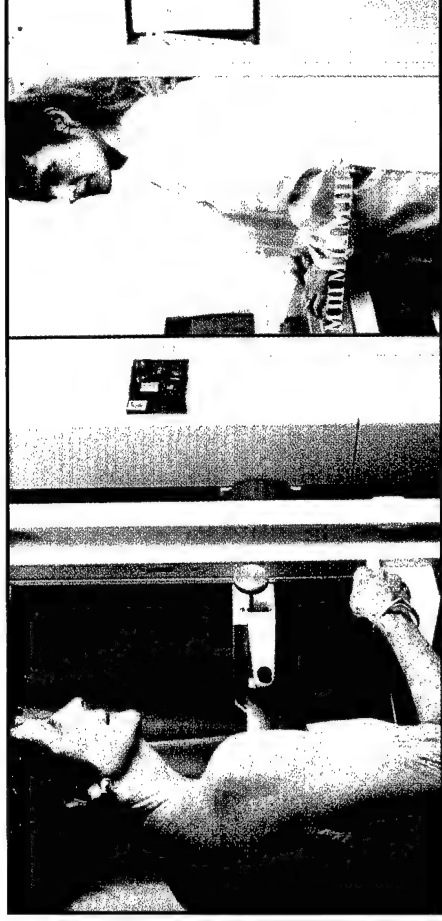
All women should know about ways to detect breast cancer early:

- Monthly Breast Self-Examination
- Mammography
- Clinical Breast Examination

The purpose of screening is to find cancer at the earliest possible stage. Hopefully, early treatment will prevent it from spreading to other areas of the body.

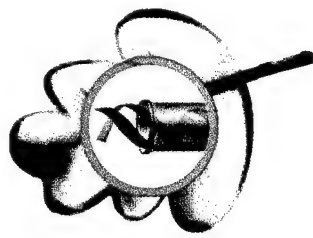


Breast Self-Examination



Mammography

There are still **many** gaps in what we know about inherited breast cancer. Research is looking at causes, risk factors, prevention, diagnosis, and treatment options. What we know about inherited breast cancer is changing all the time.



Genetic Testing

For some people, genetic testing is one way to learn more about cancer risk. In this section, you will learn about:

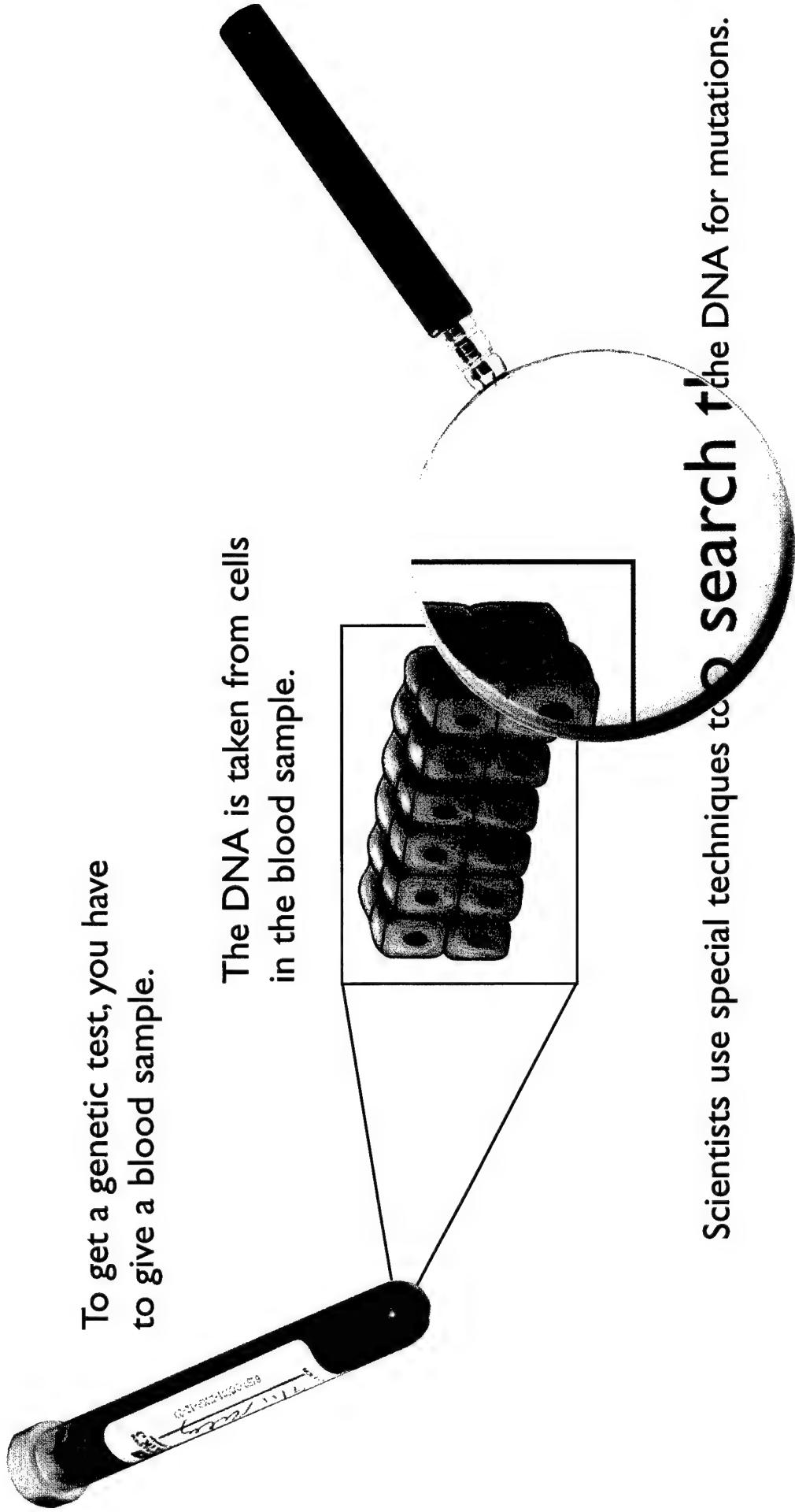
- Genetic testing
- What the results mean
- Limitations of genetic testing
- Benefits of genetic testing
- Risks of genetic testing
- Confidentiality
- Making the decision to be tested

What is genetic testing?

Genetic testing may tell you if you have a mutation that might lead to cancer or other conditions.

To get a genetic test, you have to give a blood sample.

The DNA is taken from cells in the blood sample.



Scientists use special techniques to search the DNA for mutations.



A "positive"
test means that
a mutation was
found.



A "negative"
test means that
a mutation was
not found.

Keep in mind that no test is perfect. The results might not be clear enough to tell whether it is positive or negative.



Before you make a decision about genetic testing, you should learn about its limitations. In other words, you should know what a genetic test can and cannot tell you.

Some genetic tests cannot find all mutations.

Genetic tests do not always tell you how serious a disease will be if you get it.

Genetic tests do not give definite answers. A positive test (when a mutation is present) may not tell you for sure if you will or will not get a disease. It may help you learn about the **chance** of developing a disease.

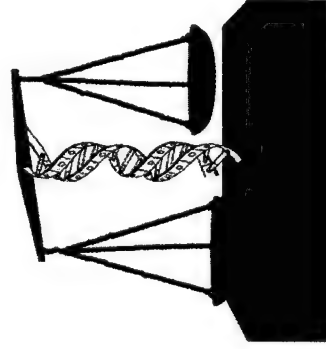
Genetic testing does not look at other factors that affect your health. Your chances of getting a disease (and how severe it might be) may be affected by other things. Some of these are diet, exercise, and smoking.

If you do **not** have a mutation, you may feel a sense of relief.

However, it does **not** mean you are not at risk for the disease. All women are at risk for breast cancer.

If you **do** have a mutation, it does not always mean you will get the disease. You can learn ways to help prevent the disease.

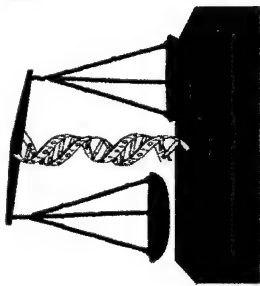
For example, a woman who finds out that she has a mutation in a breast cancer gene may decide to change her diet and to exercise more.



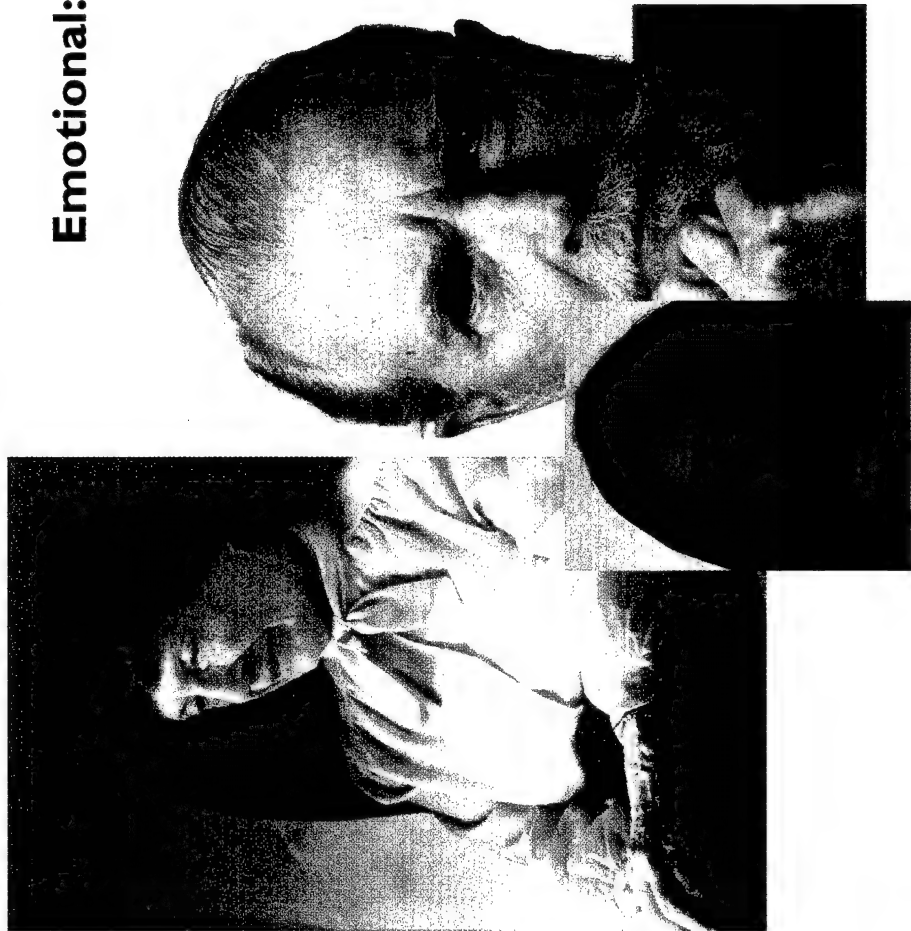
**Genetic testing
can help you
make decisions
about the future.**

The results of genetic testing may help you and your doctor choose ways to find cancer early.

For example, a woman who finds out that she has a mutation in a breast cancer gene may have her first mammogram at a younger age.

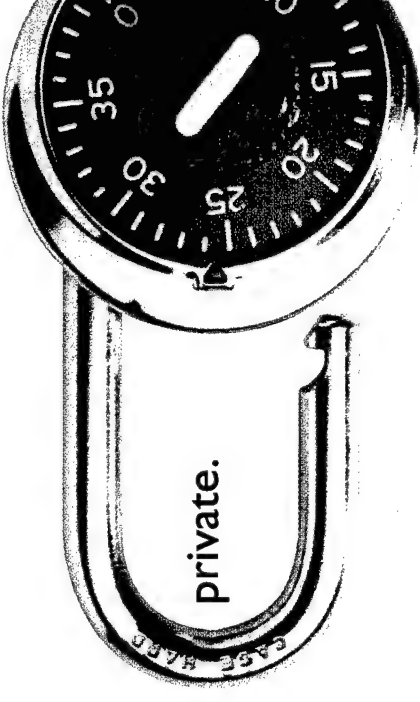


Physical: Genetic testing involves giving a blood sample.
There are few physical risks associated with giving a blood sample.



Emotional: Genetic testing
has emotional risks.
Finding out test results
may cause feelings of
depression,
guilt,
fear,
& confusion.

You may want your test results to be



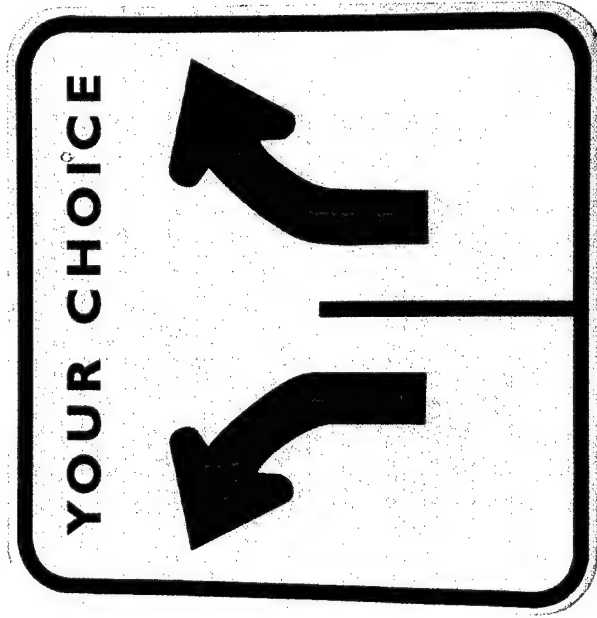
The results of genetic tests are usually recorded in medical charts.

You may need to give the information in your medical chart to apply for health or life insurance or a job.

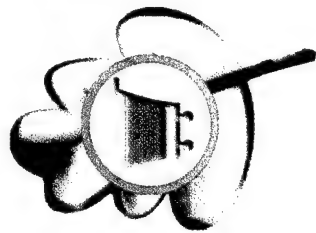
Some test results may cause problems getting insurance or a job.

There are some laws in place (and some being discussed) that may prevent insurers or employers from using genetic test results against you.

The decision
to get tested is



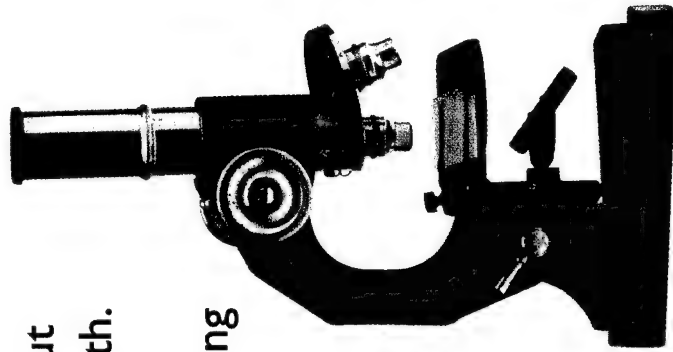
Genetic counselors
and other health professionals
can answer
your questions
and help you
think through
your decision.



Managing Your Cancer Risk

Each day we learn
more and more about
how genes affect health.

But even genetic testing
often can't tell us
for sure if
we will get
a given disease.



Research is helping us understand if and how mutations in genes can cause disease—and if we have a mutation that puts us at risk for certain conditions.

Research is also helping us understand that we have at least **some** control over our health.

Certain behaviors (such as eating well and getting regular exercise) may **lower** the risk of certain conditions.

The American Cancer Society (ACS) and the National Cancer Institute (NCI) offer hints to people who want to lower their risk for cancer.

These hints include things that we should add to our daily routine and those we should subtract. These tips may help protect you from cancer and heart disease.

For additional information, contact ACS at 1-800-227-2345, NCI at 1-800-4-CANCER, or the University of Michigan Cancer AnswerLine at 1-800-865-1125.

This section tells you how to manage and even lower your risk for certain types of cancer.

It gives you information on the following topics:



Nutrition



**Physical Activity
& Weight Control**



Smoking



Alcohol

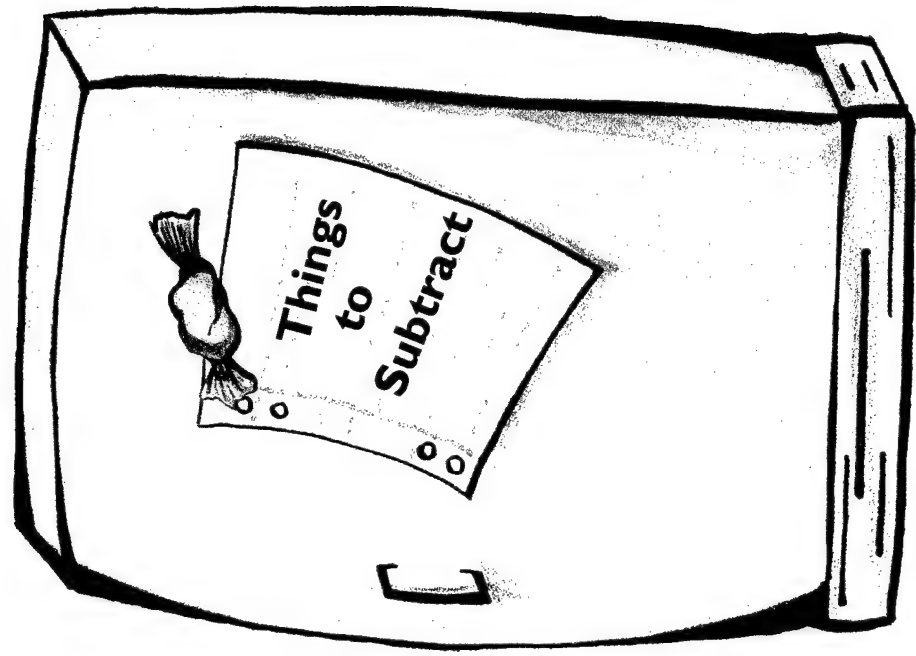
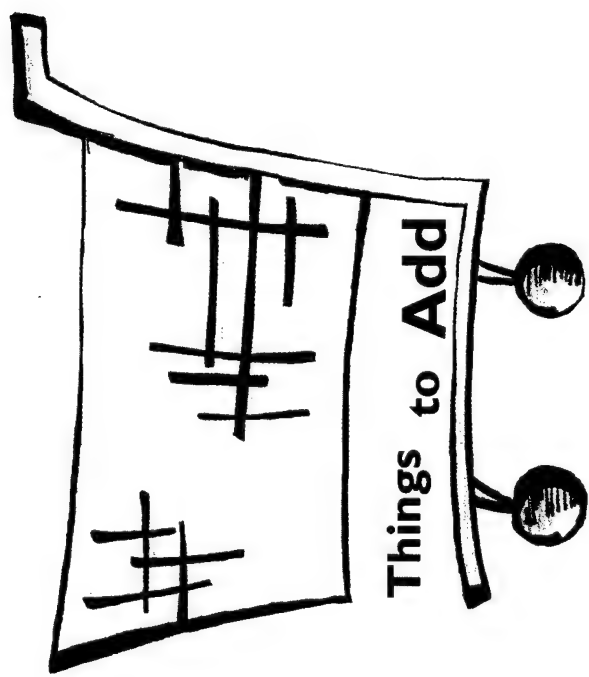
We hope this section helps you decide which behaviors you want to change and how to change them.

By now, you have probably heard that you should eat foods high in fiber and low in fat.

But eating a **healthy diet**
isn't always easy.



This section gives you a few tips on how to improve your diet. It will teach which foods are the best for you and may help reduce your risk of certain types of cancer.



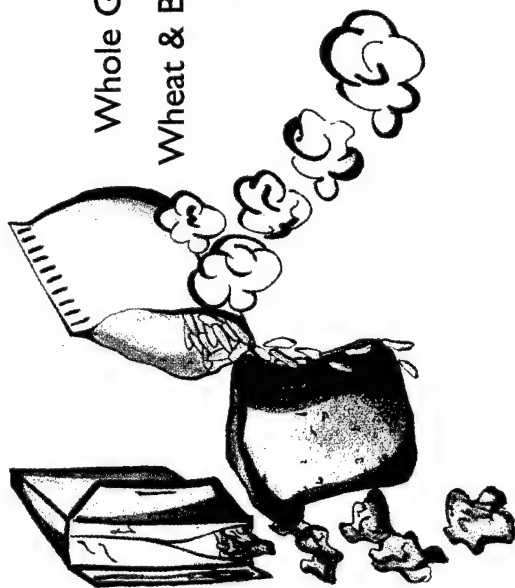
Fiber (sometimes called roughage) comes from plants.

Whole grains, fruits, legumes, and vegetables are significant sources of fiber.

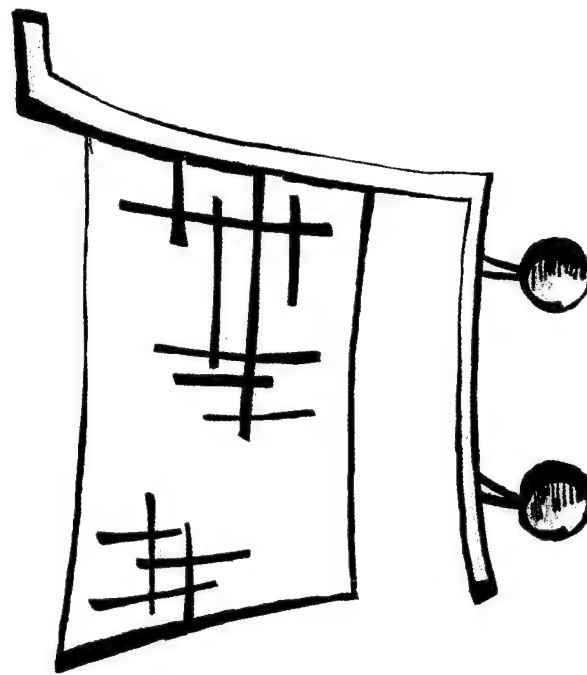
Fiber appears to decrease colon cancer risk because it helps move cancer-causing agents out of the intestines

It is best to eat fiber that comes from many different sources.

Some of these sources are:



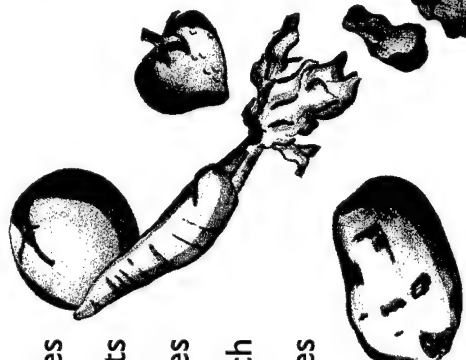
Whole Grain Breads
Wheat & Bran Cereals
Brown Rice
Popcorn



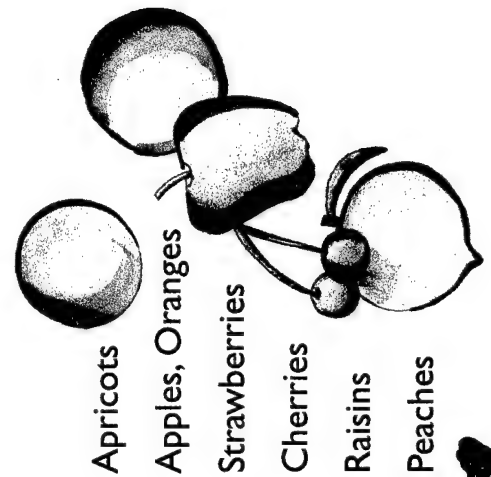
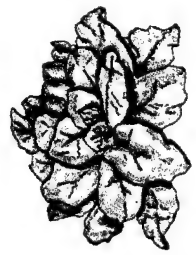
Things to Add



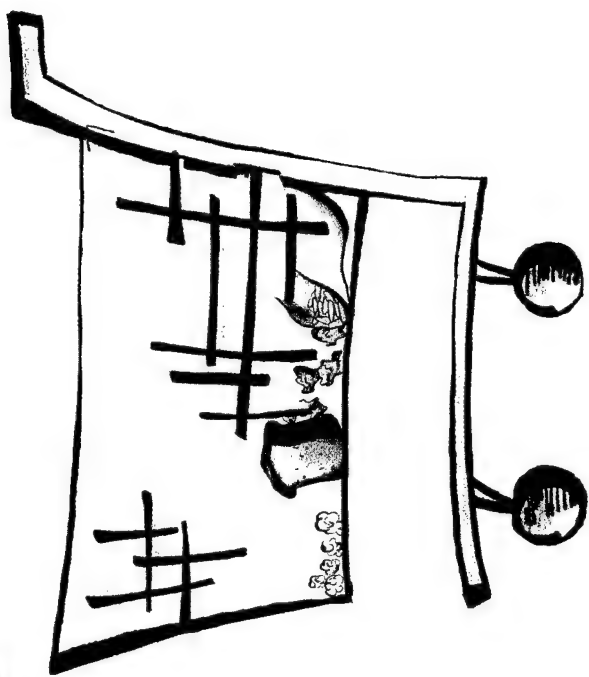
Peas, Tomatoes
Broccoli, Carrots



Kidney Beans & Other Legumes
Spinach
Potatoes



Apricots
Apples, Oranges
Strawberries
Cherries
Raisins
Peaches

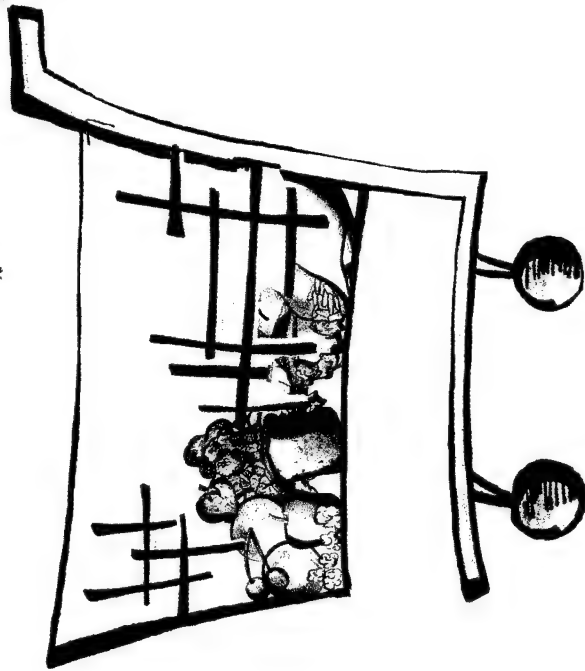


Cruciferous (crew-sif-er-us) vegetables may help protect against colon, bladder, stomach, lung, and other cancers.

Experts say you should eat a
V a R i e T y
of these vegetables every day.

You can add them to your diet by simply putting them in your salad, stir fry, casserole, or eating them as a side dish or snack.

Cruciferous vegetables include:



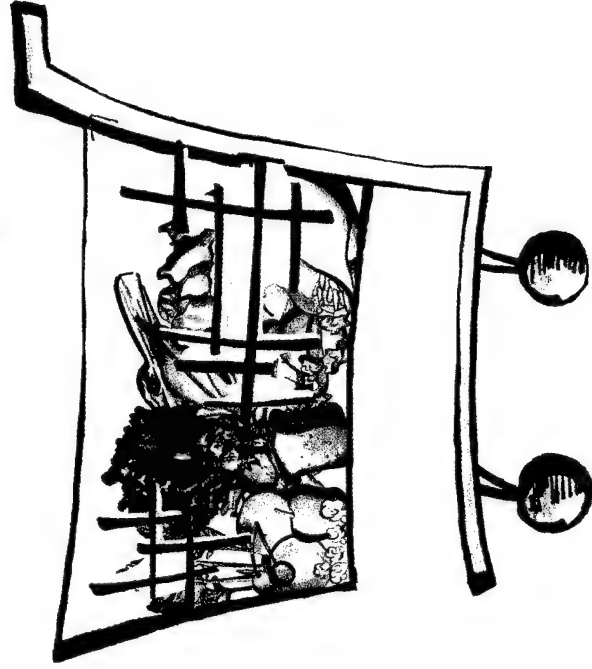
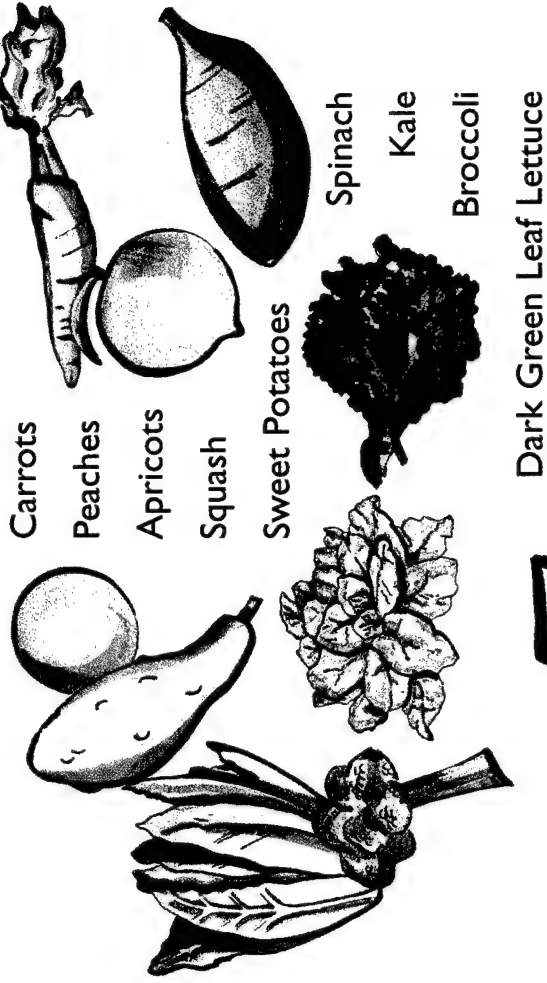
Vitamin A and carotenoids (car-ott-en-oids) may protect against cancers of the esophagus and larynx.

Your body gets vitamin A and carotenoids from the food you eat.

Food sources of Vitamin A are:

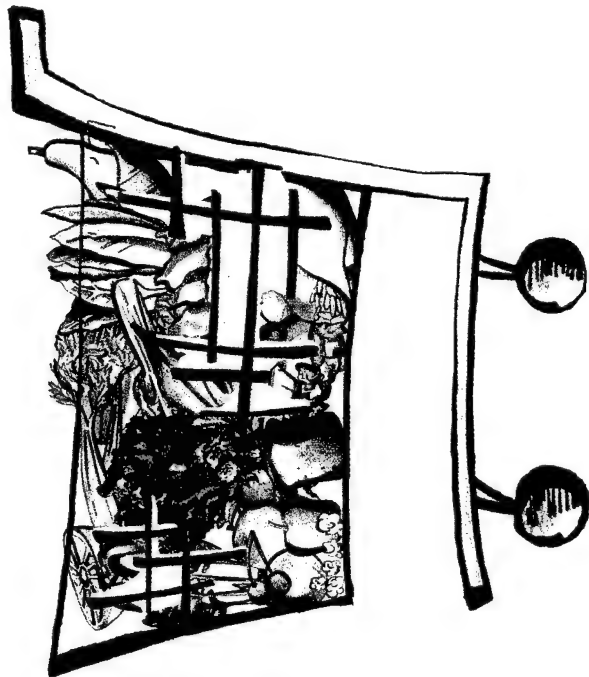
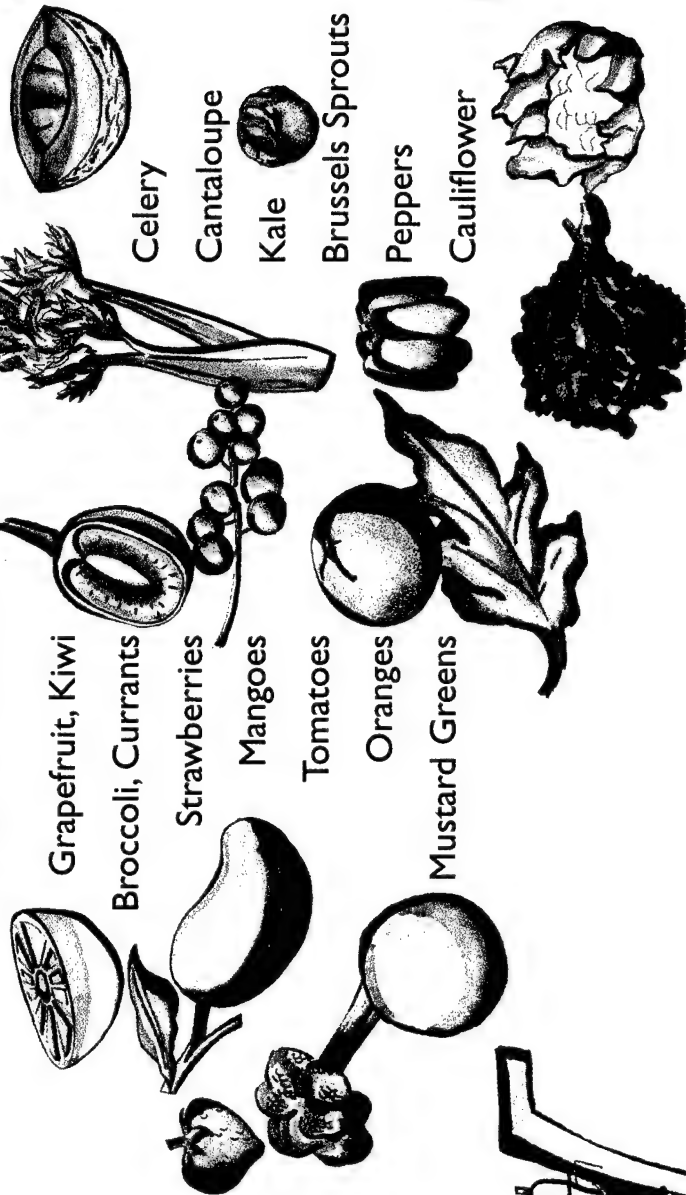
- egg yolks
- dairy products
- fish
- liver and other organ meats

Food sources of carotenoids are some dark green and deep yellow fruits and vegetables:



Vitamin C may protect against certain types of cancers, including cancers of the esophagus and stomach.

Vitamin C is found in many fresh fruits and vegetables such as:



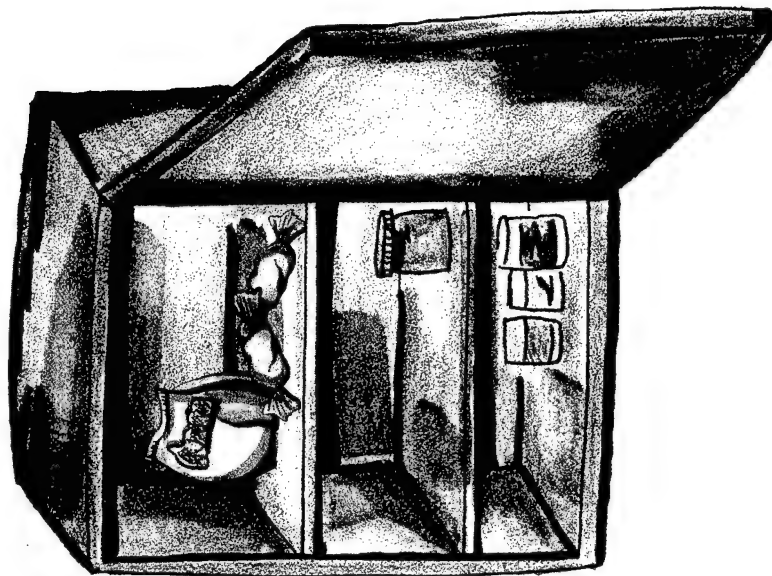
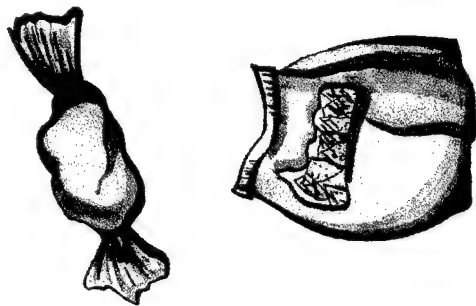
Some fats are **HIDDEN**

and can be found in pastries, certain candy, and many snack foods.

High fat diets are also high in calories which may lead to weight gain.

Look at food labels for fat content to help you keep track of the fat you eat.

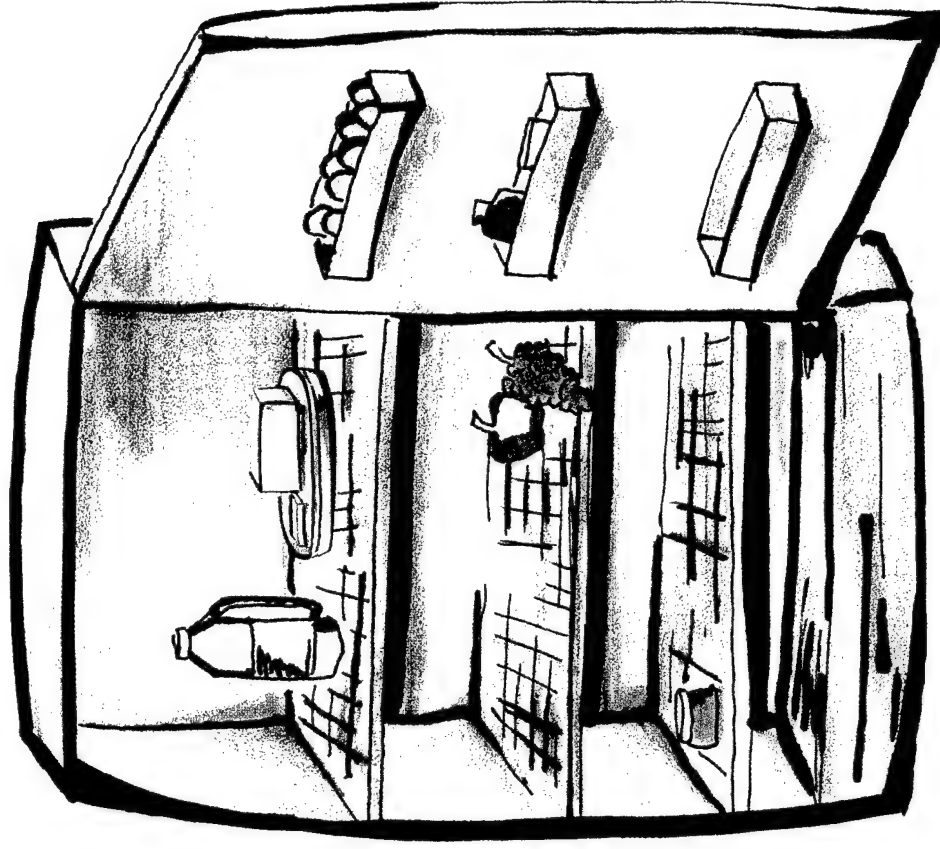
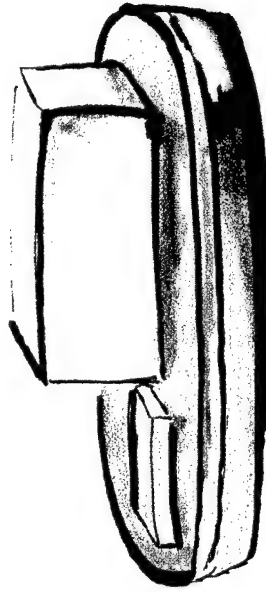
Nutrition Facts		Amount/serving	%DV*	Amount/serving	%DV*	
Total Fat 12 g		18%	Total Carb. 29 g			10%
Sav. Size 1 bar						
Calories 230		Sat. Fat 7 g		Fiber Less than 1 g		3%
Fat Cal. 100		Cholest. 10 mg		Sugars 24 g		3%
		Sodium 65 mg		Protein 2 g		
		Vitamin A 0%		Vitamin C 4%		Iron 0%
*Percent Daily Values (DV) are based on a diet of 2,000 calorie diet.						
INGREDIENTS: MILK CHOCOLATE (SUGAR, MILK, COCOA BUTTER, CHOCOLATE, LACTOSE, MILKFAT, SOY LECITHIN - AN EMULSIFIER, VANILLIN - AN ARTIFICIAL FLAVORING), CRISPED RICE (RICE, SUGAR, SALT, MALT).						



No more than 20-30% of the calories you eat in one day should come from fat.

Certain meats and high fat dairy products (such as butter or cream) are sources of fat that you should subtract from your diet.

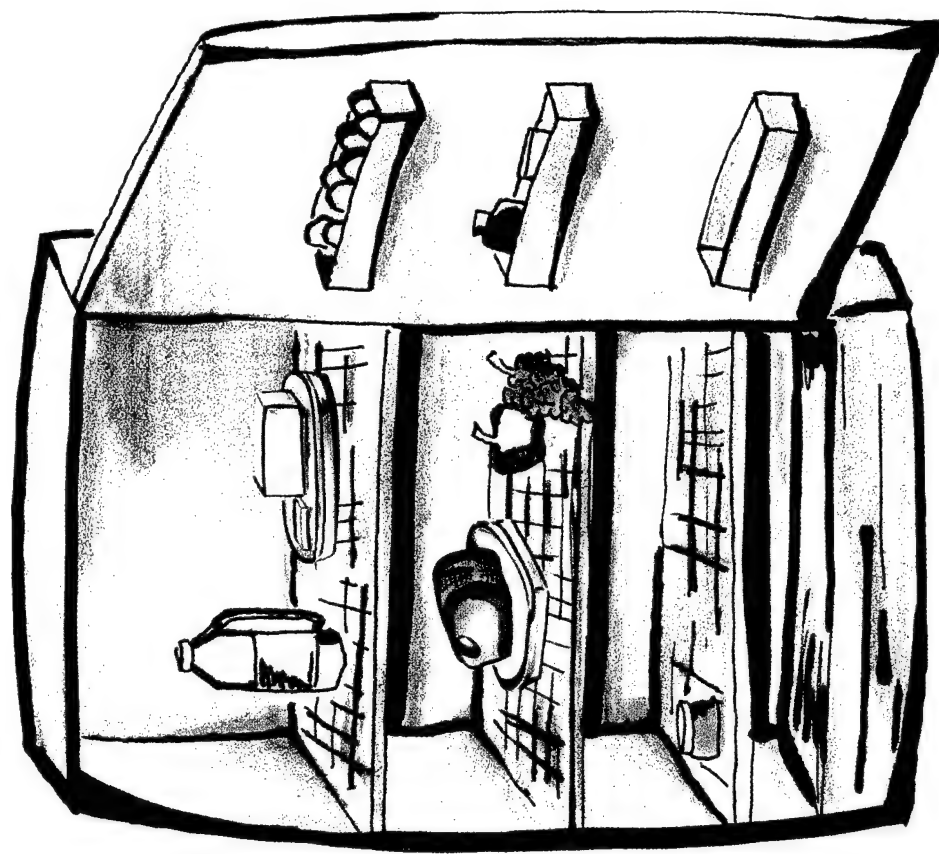
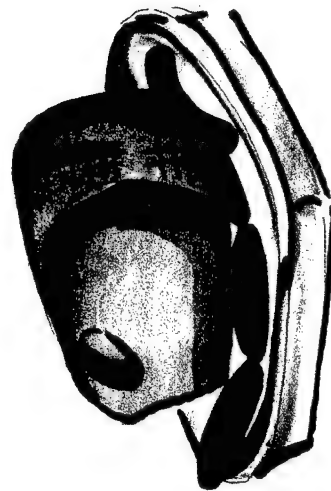
A diet **high** in fat may increase your risk for breast, colon, and prostate cancers.



Meat and fish are often treated to keep them fresh. For example, they may be coated in salt (salt-cured) or nitrites (nitrite-cured), or smoked.

Eating large amounts of meat and fish that are treated in these ways may lead to cancers of the esophagus and stomach.

Try to avoid meat or fish treated in these ways.



Things to Subtract

If you use meat, use these tips to lower the fat content:

buy lean meat

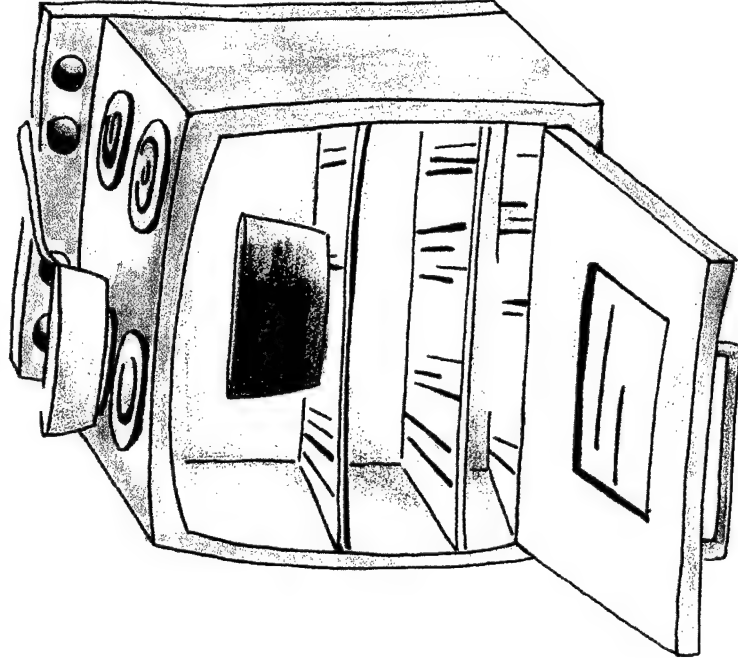
remove the skin from poultry before you cook it

bake or broil meats instead of frying them

trim visible fat from roast, steak, and pork

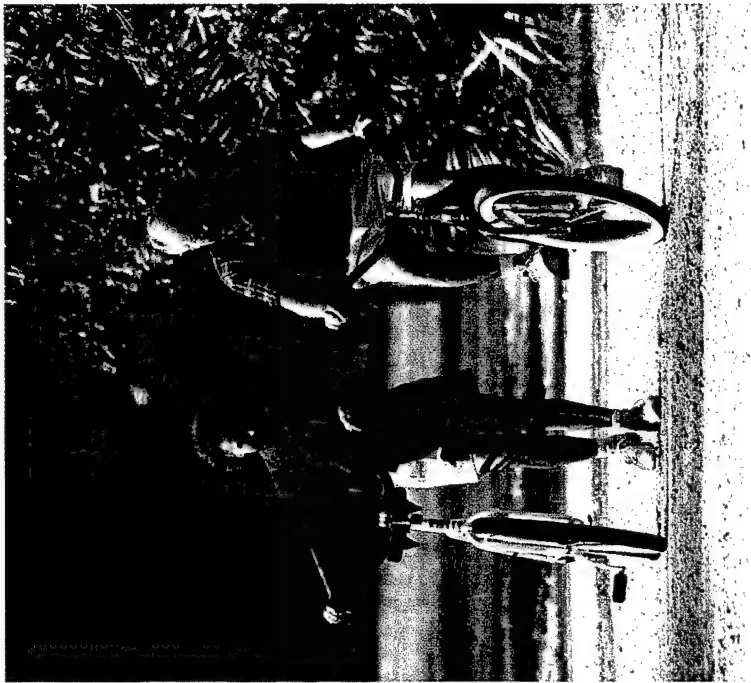
Nuts and vegetable oils also contain fat, but may be better than animal fats.

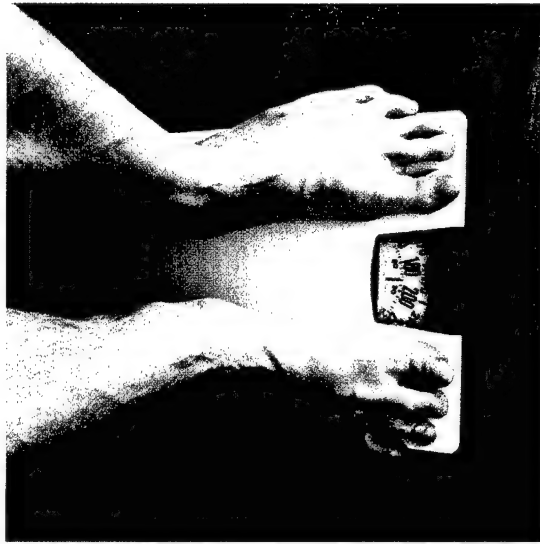
When you use oil, try to use olive oil.



Experts say that being physically active can improve your health in many ways.

This section talks about how physical activity can help reduce your risk of some types of cancer.





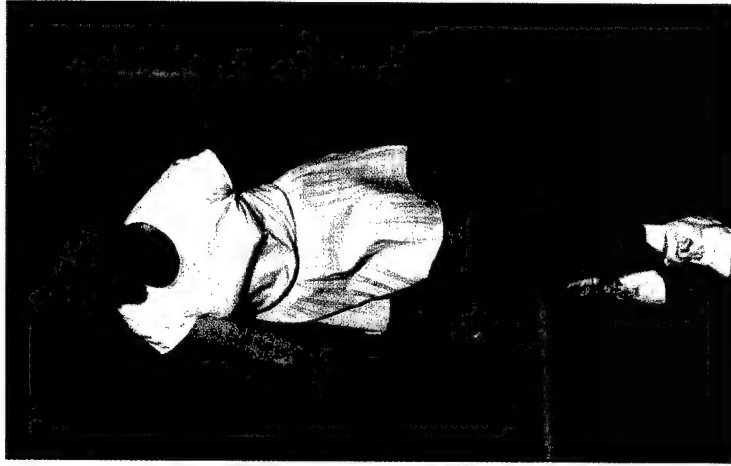
People who are very overweight may be at higher risk for cancers of the uterus, gall bladder, breast, and colon.

Adding physical activity to your life and subtracting calories from your diet can help you lose weight and avoid weight gain. Being more active and eating fewer calories can help you reach and keep your ideal weight.



Physical activity does not mean only doing **heavy** exercise such as

running, lifting weights, or aerobics.



Physical activity simply means moving around to burn energy.

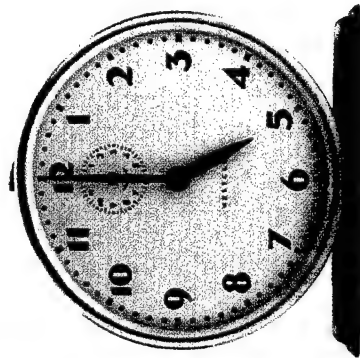
This may include simple things such as walking at the mall, housework, or yardwork.

Being active has many **benefits.**

Physical activity

- ☐ lowers depression and anxiety
- ☐ gives you **MORE** energy
- ☐ lowers your risk for heart disease, high blood pressure (hypertension), and diabetes
- ☐ helps build muscle strength
- ☐ helps prevent weight gain and obesity

You can add physical activity to your life in many ways.



Try some of these:

Plan time in your day to exercise.

Take the stairs instead of the elevator.

Get off the bus a few stops earlier.

Take a walk during your lunch break.

Walk, instead of drive, to the store.

People may be able to lower their risk of breast cancer by doing aerobic exercise 4 to 6 hours per week.

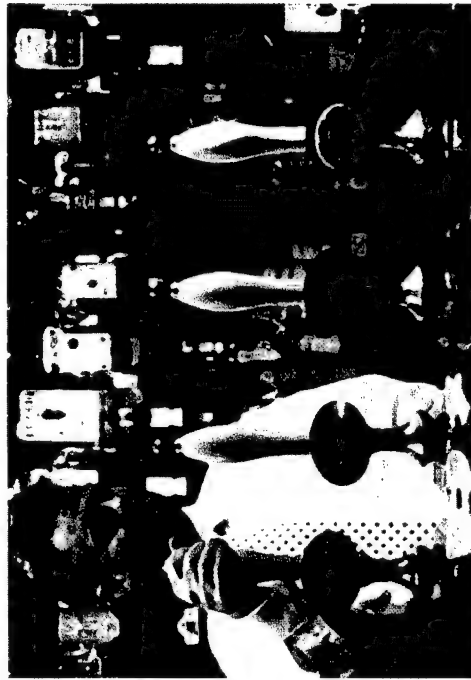
Every little bit of physical activity counts.

You can break up the time you are active into several 10-minute blocks. The goal is to work out for 30 minutes on most days of the week.

Before you start an exercise program, you should talk with your doctor.

Research has shown that alcohol may raise your risk for certain types of cancers.

This section talks about ways you can lower your risk.



For women, the risk of breast cancer doubles when they regularly have two drinks of alcohol a day.

Drinking alcohol raises your risk for cancers of the liver, esophagus, mouth, throat, and bladder.

Heavy drinkers who also smoke
are at greater risk for cancers
of the mouth, throat, larynx, and esophagus
than people
who
do not
smoke.

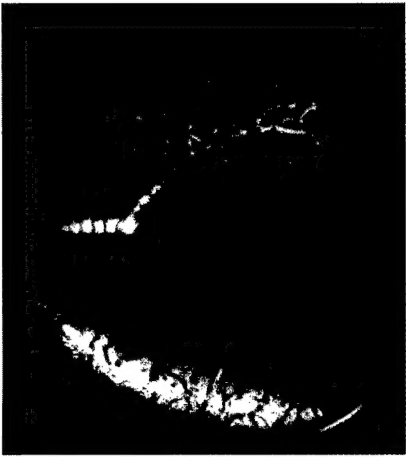
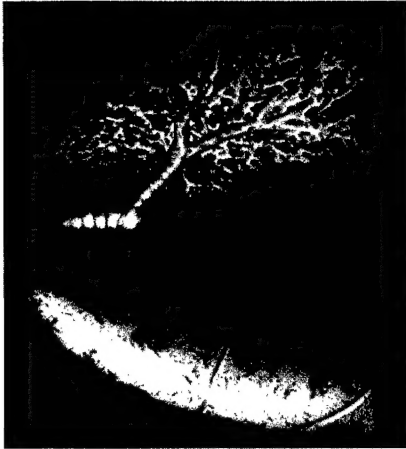
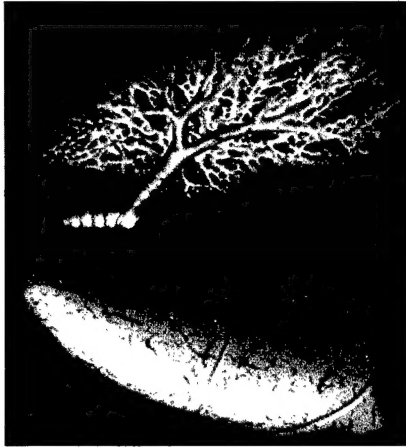
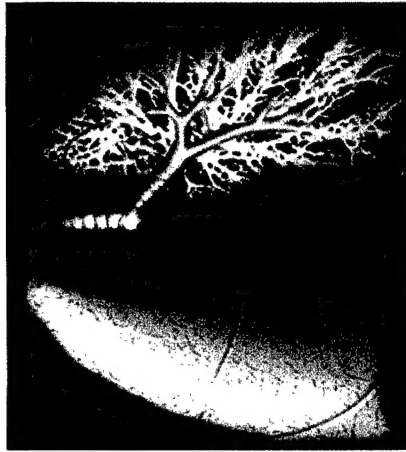


To help prevent cancer,
drink alcohol in moderation.



In other words, have no more
than 3 or 4 drinks per week.

Tobacco use is the number one preventable cause of disease and death in the United States. If no one used tobacco, 420,000 fewer people would die each year.



This section talks about tobacco and how it may increase your risk for cancer or complicate cancer treatment.

Cigarettes and other tobacco products (such as snuff or chewing tobacco) contain chemicals that are addictive and very harmful to your body.



Smoking is the main cause of lung cancer. It can also cause heart and lung disease.

Breathing second hand smoke (smoke from a burning cigarette) can lead to breathing problems, allergies, or asthma.

Smokeless tobacco (such as snuff or chewing tobacco) is also harmful to health.



Chewing tobacco increases the risk of mouth and throat cancers.

Smoking during pregnancy is harmful to the unborn baby.

It is a risk factor for:

low birth weight

premature birth

other health problems



Children of smokers are more likely to smoke (and tend to start earlier) than children of non-smokers.

Among women, lung cancer causes more deaths than breast cancer.

Smoking may also lead to cancers of the mouth, larynx, esophagus, and bladder.



Treating cancer in women who smoke is more difficult than in women who do not smoke.

We hope that you have gained a better understanding of cancer and genetics. If you have more questions or if you would like more information about the contents of this book, talk with your health care provider or call the University of Michigan Cancer AnswerLine at 1-800-865-1125.